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OHIO MOSSES, DICRANALES.*

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In the present paper, the writer has treated the Dicranales in the same manner as the Polytrichales and Bryales were treated in previous papers. Some species have been included which have never been reported from Ohio but which, without doubt, are to be found in the state. Probably many others may be found which are not included. The order as presented is comprised of the acrocarpous mosses with a single peristome, the Aplolepideæ. Fissidens has been included in the group although some of the species of that genus are pleuricarpous.

DICRANALES.

Minute to large mosses with usually erect, branched gametophores and the archegonia situated at the tip of the main stalk or of ordinary branches. Peristome single, with the teeth composed of plates made by a deposit on the outer and inner sides of the original cell wall of a single layer of cells; teeth transversely barred, often split; sometimes wanting.

SYNOPSIS OF THE ORDER.

I. Scales three or more ranked.
  A. Calyptra not unusual.
    1. Scales formed of a single layer of cells; plants light to dark green.
      a. Peristome teeth not tortuose.
        1′. Teeth not striate, not regularly cleft, sometimes wanting, GRIMMIACEÆ
        2′. Teeth striate.
          a′. Not cleft to the base, divisions broad. . SELAGERIACEÆ
          b′. Cleft nearly or quite to the base, divisions narrow, DICRANACEÆ
      b. Peristome teeth tortuose. . . . . TORTULACEÆ
    2. Scales formed of three layers of cells; plants pale green or grayish. . . . . LEUCOBRYACEÆ
  B. Calyptra entirely enclosing the sporangium. . . . . ENCALYPTACEÆ
II. Scales two-ranked with edges toward the stalk. . . . . FISSIDENTACEÆ

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KEY TO THE FAMILIES OF DICRANALES.

1. Light gray (scarcely green), forming dense tufts in moist shade..LEUCOBRYACEÆ
1. Light green to almost black..... 2
2. Scales in two rows with edges towards the stalk.....FISSIDENTACEÆ
2. Scales in three or more rows, edges not toward the stalk..... 3
3. Plants black or blackish with colorless scale apices, growing on rocks, GRIMMIACEÆ
3. Plants green to light yellowish-green, or if dark, then on the soil..... 4
4. Scales papillose, spatulate to ligulate..... 5
4. Scales not papillose, or if so, then acuminate..... 6
5. Calyptra cucullate; costa often excurrent.....TORTULACEÆ
5. Calyptra not cucullate; costa not at all or barely excurrent....ENCALYPTACEÆ
6. Very small mosses on rocks; peristome teeth not 2-parted, broad; costa cells homogenous.....SELIGERIACEÆ
6. Small to large mosses; teeth 2-parted, narrow; costa cells heterogenous, DICRANACEÆ

GRIMMIACEÆ.

Cespitose mosses; scales blackish, often with colorless apices, lanceolate; seta short, sporangium immersed or emergent, globose to cylindrical, peristome single of 16 papillose teeth, red or yellowish; calyptra small; usually on rocks.

1. Scales crisped, without hyaline point, costa with median guides; sporangium immersed.....*Glyptomitrium*
1. Scales not crisped, point usually hyaline, costa with basal guides or homogenous; sporangium immersed or exserted..... 2
2. Branches irregular or short; teeth filiform, divided almost to the base, *Rhacomitrium*
2. Branches of almost equal height; teeth undivided or only in the outer half, sometimes none.....*Grimmia*

1. GLYPTOMÍTRIUM Brid. (*Ptychomitrium* Fuern.).

Greenish-yellow to blackish, radiculose at the base; scales dense, spreading when moist, costa percurrent or ending below the apex; setae straight, usually clustered; sporangium erect, exserted, peristome inserted below the mouth, teeth usually divided, operculum with a straight point; calyptra campanulate, deeply lobed. Autoicous.

Glyptomitrium incûrvuum (Schwaeg.) Broth. (*Ptychomitrium incurvuum* Sull.). Dark green, densely cespitose, erect, up to ¼ in. tall; scales linear-lanceolate, obtuse, margin plane, costa ending at the apex; lower scales smaller than the upper; sporangium ovoid, operculum almost as long as the urn. Spring. On limestone rocks. There is no specimen in the herbarium but the species is reported as common in southern Ohio by Lesquereux and James.

2. GRÍMMIA Ehrh. Hedw.

Densely cespitose; scales crowded, lanceolate with a hyaline point, squarrose-recurved when moist; lower ones smaller, entire acuminate, concave, plane or revolute; perichaetial scales larger; seta short sporangium rarely exserted, globose, to cylindrical peristome reddish-brown, rarely absent.

1. Hyaline point a long hair; sporangium shorter than the seta....*G. laevigata*
1. Hyaline point short, sometimes not pointed; seta shorter than the sporangium..... 2

2. Scales narrow, obtuse; loosely cespitose; brownish-green.....*G. apocarpa*
2. Scales acuminate; densely cespitose; green..... 3
3. Sporangium oblong-ovate, smooth.....*G. pennsylvanica*
3. Sporangium globose-ovate, wrinkled when dry.....*G. conferta*

Grimmia apocárpa (L.) Hedw. ¾–1 in. in height; scales ovate-lanceolate, erect spreading, margin recurved, costa ending at or near the apex, basal cells usually sinuose walled; sporangium immersed, reddish-brown, operculum short-rostrate, peristome reddish-brown, columnella often falling with the operculum. Late spring. On stones. Lake, Clarke, Franklin, Hamilton.

Grimmia conférta Funck. Dense cushions of bright green to grey-green mosses; gametophores slender; scales lance-ovate to oblong, denticulate, costa ending at the apex; sporangium wide-mouthed, peristome teeth light red to orange, operculum apiculate. Spring. On exposed rocks. Lake Co.

Grimmia pennsylvánica Schwaeg. (*G. pilifera* Beauv.). Dark green, up to 1 in. or more tall; scales dense, ovate-lanceolate, margins recurved, apex rough, costa ending in the apex, base yellowish; seta about half as long as the sporangium, sporangium immersed, oblong-ovate, smooth; peristome teeth irregularly split. Autumn. Moist shaded rocks. Clarke, Fairfield, Lake.

Grimmia laevigàta Brid. (*G. campestris* Bruch.; *G. leucophaea* Grev.). Loosely cespitose, dark green, hoary because of the hyaline points which are often as long as the rest of the scale; scales dense, larger at the top of the gametophore, ovate-oblong, concave, margins plane, points decurrent along the laminæ; lower scales without the hair point, costa ending in the apex; sporangium elliptical-oblong, smooth, brownish, included; calyptra mitrate, lobed. Spring. Noncalcareous rocks. Reported from Ohio by Lesquereux.

3. RACOMÍTRIUM Brid.

Robust, loosely cespitose mosses, radiculose at the base, procumbent to erect, uniformly foliate, often with short lateral branches; scales hyaline-pointed, squarrose to recurved; seta long; calyptra mitrate.

Racomitrium aciculàre (L.) Brid. (*Dicranum aciculare* Hedw.). Dull green or blackish, 2–3 in. tall, stout; scales erect-spreading, entire or distantly denticulate, costa ending below the apex; sporangium smooth, erect, mouth narrow, oblong-elliptic, brown; peristome teeth cleft to below the middle, short; calyptra smooth at the apex. Rarely found in fruit. Spring. Wet, shaded, noncalcareous rocks. Not reported from Ohio but is in Pennsylvania near our boundary.

SELAGERIACEÆ.

Small mosses growing on rocks; usually unbranched; scales 3–5-ranked, tufted above, the lower ones smaller, lance-subulate, costa cells homogenous; peristome teeth 16; calyptra cucullate; operculum rostrate.

1. Minute, gregareous; alar cells not enlarged.....*Selageria*
1. Larger, cespitose; alar cells enlarged.....*Blinda*

1. SELAGÈRIA Br. & Sch.

Stalks rarely branched, 3-angled; scales clasping, basal cells sometimes colored; seta erect, short, sporangium with distinct, stomata hypophysis; peristome teeth simple.

1. Scales entire 2
1. Scales denticulate or serrate 4
2. On sandstone; seta recurved when moist; sporangium narrow-mouthed, *S. recurvata*
2. On limestone; seta erect, or slightly curved when moist, sporangium wide-mouthed 3
3. Scales 3-ranked; plants .1–.3 in. tall, branched ..... *S. trifara*
3. Scales not 3-ranked; plants less than .1 in. tall, simple ..... *S. calcarea*
4. Awn long, tapering; seta erect when moist 5
4. Awn short, papillose; seta recurved when moist ..... *S. campylopoda*
5. Yellowish-green; peristome wanting ..... *S. doniana*
5. Dark green; peristome present ..... *S. pusilla*

Selageria doniàna (Sm.) C. Muell. (*Gymnostomum donianum* Smith; *Anodus donianus* Br. & Sch.) Simple; scales dense, erect, straight, channelled; costa filling the awn, perichaetial scales not subulate, sheathing, antheridia in basal buds; seta straight, sporangium ovoid, hemispherical when empty, hypophysis short, peristome wanting, operculum oblique. Summer. Mrs. Britton reports this species for Ohio.

Selageria pusílla (Ehrh.) Br. & Sch. (*Swartzia pusilla* Ehrh.; *Weisia pusilla* Hedw.). Gregarious, bright dark green mosses; scaleless at the base; scales with an ovate-lanceolate base, costa nearly filling the awn, margins recurved; antheridia in lateral buds; seta erect, sporangium oval-pyriform, mouth wide; operculum oblique-rostrate; peristome red or brown, teeth reflexed when dry. Summer. Erie, Logan.

Selageria calcàrea (Dicks.) Br. & Sch. (*Bryum calcareum* Dicks.; *Weisia calcarea* Hedw.). Dark green simple mosses; scaleless below, crowded above, scales erect at the apex, ovate, abruptly subulate, clasping, toothed below, subula entire; costa filling the awn; antheridia in basal buds; seta erect, thick, sporangium erect, pyriform-ovoid, turbinate when dry, brownish, operculum conic-rostrate. Spring. Mrs. Britton reports it from Columbus, Ohio.

Selageria trifària (Brid.) Lindb. (*Weisia trifaria* Brid.; *S. tristichia* Br. & Sch.). Cespitose, gametophores erect up to ⅓ in. tall, with numerous sub-apical branches; scales 3-ranked, erect-appressed, base narrow, entire, costa broad, excurrent, awn slender and rough; seta erect, pale yellow; sporangium ovoid-pyriform, broadly turbinate when empty, hypophysis long, stomatose, peristome red; antheridia in lateral buds. Summer. Reported from central Ohio in Lesquereux and James Manual.

Selageria recurvàta (Hedw.) Br. & Sch. (*S. setacea* (Wulf.) Lindb.). Gregarious, dark green; scales erect-spreading, caniculate, entire; perichaetial scales tubulose; seta yellowish, arcuate, more erect when old; sporangium ovoid to globose, hypophysis short; peristome orange-pellucid. On rocks in shade. Not reported.

Selageria campylopoda Lindb. (*S. recurvata* var. *arcuata* Lesq. & Jas.). Gregareous, simple; scales crowded, costa ending below the apex, basal cells oblong, marginal ones linear, clear; seta recurved when moist, lid beaked, peristome red or brown. Early fall. Mrs. Britton includes Ohio in the distribution of this species but no definite reports have been made.

2. BLINDA Br. & Sch.

Densely cespitose, branching by apical innovations; scales crowded scarcely secund, lance-subulate, caniculate, cells enlarged and orange colored at the base; sporangium sub-globose, calyptra covering the upper half of the sporangium.

Blinda acùta (Huds.) Br. & Sch. (*Weisia acuta* Hedw.; *Grimmia acuta* Sm.; *Bryum acutum* Huds.). Yellowish-green to brown or black, ⅓-2 in. tall, almost naked below; scales almost entire; seta long; peristome bright red. On rocks. Summer. No report.

DICRANACEÆ.

Gametophores in dense tufts, erect, branched; scales dense, usually falcate-secund, apex usually acuminate; seta usually long: sporangium zygomorphic, cernuous, sulcate when dry; peristome of 16 teeth, usually divided, minutely striate or papillose, sometimes wanting.

1. At least the upper cells of the scales papillose 2
1. None of the cells of the scales papillose 5
2. Small mosses, less than ⅓ in. tall ..... *Rhabdoweisia*
2. Larger, ⅓ in. or more tall 3
3. Alar cells distinctly inflated, often red ..... *Dicranum*
3. Alar cells larger than the others, but not inflated 4
4. Scales sheathing, acuminate or subulate, not crisped ..... *Oncophorus*
4. Scales not sheathing, not subulate or acuminate, crisped ..... *Ceratodon*
5. Alar cells inflated, often colored 6
5. Alar cells not inflated 8
6. Costa narrow; seta erect; sporangium stomate ..... *Dicranum*
6. Costa broad; seta curved; sporangium without stomata 7
7. Calyptra entire; teeth cleft ¾ to the base ..... *Dicranodontium*
7. Calyptra fringed at the base; teeth cleft to about the middle, confluent at the base ..... *Brothera*
8. Sporangium rupturing irregularly 9
8. Sporangium opening by a distinct lid 10
9. Sporangium pear-shaped; calyptra mitrate ..... *Bruchia*
9. Sporangium ovoid-globose; calyptra cucullate ..... *Pleuridium*
10. Hypophysis inflated, as long as the sporangium ..... *Trematodon*
10. Hypophysis short or sporangium without a distinct neck 11
11. Sporangium nearly actinomorphic and erect; teeth cleft to the base. *Ditrichum*
11. Sporangium mostly zygomorphic, not erect; teeth cleft about half way to the base, confluent at the base ..... *Dicranella*

1. BRÛCHIA Schwaeg.

Green protonema sparingly persistent, gametophores simple; scales crowded at the apex, smaller below, subulate in our species, costa broad; seta short, sporangium immersed or slightly exserted, pear-shaped, calyptra mitrate, neck distinct, stomate.

1. Awn smooth; plants up to ⅓ in. tall; sporangium ovoid-pyriform. . *B. flexuosa*
1. Awn rough, plants minute; sporangium ovoid-oblong ..... *B. sullivantii*

Bruchia flexuòsa (Schw.) C. Muell. (*Phascum flexuosum* Schw.; *B. brevicollis* Lesq. & Jas.). Small gregareous mosses, about ⅛ in. tall; scales erect-spreading from a convex base, sub-papillose, alar cells not differentiated, antheridia in the axils of the comal scales or in separate buds; seta usually shorter than the cleistocarpous sporangium. On clay soil in bare fields. May and June. Fairfield Co. This species is probably more common than the records would indicate.

Bruchia sullivántii Aust. (*B. flexuosa* Sull.). Small, gregareous, almost stemless mosses; scales broadly ovate at the base, abruptly subulate; seta and sporangium yellow, neck longer than in the preceding species; abundantly fruiting. Wet clay soil. June and July. Reported from Ohio by Jennings.

2. TREMÁTODON Rich.

Low, simple, cespitose mosses with yellowish-green, lancesubulate, clasping scales; costa board, alar cells not inflated; seta yellow, usually erect; neck inflated, stomatose; peristome persistent; calyptra cucullate.

1. Neck as long as the sporangium; scales not crisped when dry, costa filling the awn.....*T. ambiguus*
1. Neck almost twice as long as the sporangium; scales crisped when dry, costa not filling the awn.....*T. longicollis*

Trematodon ambîguus (Hedw.) Hornsch. (*Dicranum ambiguum* Hedw.). Sparingly branched, ⅓–1 in. tall; scales abruptly contracted into a long subulate point, awn serrulate, perichaetial scales longer; seta erect, ½–1½ in. long; sporangium orange, cernuous, neck somewhat strumose, urn oblong, horizontal, operculum long-beaked. Late summer. Old fields among the grass. Not reported.

Trematodon longicóllis Michx. Smaller than the preceding, about ¼ in. tall; sporangium uniformly cylindrical-oblong. Clay soil or sand in old fields. Reported from "northern Ohio" by Lesquereux.

3. PLEURÍDIUM Brid.

Gregareous or cespitose, low, green and glossy mosses, with simple or branched gametophores; scales small, erect-spreading, distant, not crisped, upper ones crowded, long-subulate; sporangium cleistocarpous, immersed, erect, ovoid, without a neck; calyptra cucullate.

1. Perichaetial scales abruptly subulate; antheridia gemmiform in the axils of the upper scales.....*P. alternifolium*
1. Perichaetial scales gradually subulate; antheridia in the axils of the perichaetial scales.....*P. subulatum*

Pleuridium alternifòlium (Dick.; Kaulf.) Raben. (*Phascum alternifolium* Kaulf.). Densely cespitose, less than ½ in. tall, simple or branching by slender innovations; scale base oval, costa excurrent, filling the serrulate awn; sporangium yellowish to brown, operculum apiculate, with a blunt beak. Old clay fields. Not reported.

Pleuridium subulatum (Huds.) Raben. (*Phascum subulatum* Kaulf.). Densely cespitose, less than ¼ in. tall; scales ovate-lanceolate, lower

ones more nearly ovate, minutely denticulate, costa ill-defined, filling the apex; seta shorter than the erect sporangium, yellowish. April-June. Old fields among the grass. Cuyahoga.

4. DÍTRICHUM (Timm.) Hampe.

Small cespitose mosses with simple or sparingly branched gametophores; scales dense, not sheathing, without alar cells, costa broad, perichaetial scales longer; seta erect, lustrous, slender, flexuous; sporangium erect or nearly so, oval to cylindrical; peristome of 16 teeth, split nearly to the base, somewhat twisted, joined by a basal membrane; operculum obliquely conic; calyptra cucullate.

1. Bright green; scales erect-spreading, costa long-excurrent; seta light yellow; paroicous ..... *D. pallidum*
1. Yellowish-green; scales erect-appressed, costa short-excurrent or percurrent; seta red or rufous; unisexual 2
2. Scales subulate; lustrous, denticulate and slightly grooved toward the apex ..... *D. tortile*
2. Scales lanceolate; rather dull, usually entire, deeply caniculate toward the apex ..... *D. vaginans*

Ditrichum tortile (Schrad.) Brock. *D. pusillum* (Hedw.) Timm.; *Trichostomum tortile* Schrad.). Usually simple and erect, radiculase below, stalks reddish; scales erect-spreading, somewhat twisted, margins revolute, apex denticulate; seta twisted; sporangium smooth, oblong to oblong-cylindric; peristome reddish. Late autumn. Clay soil in fields or on roadsides. Belmont, Lake, Franklin.

Ditrichum vaginans (Sull.) Hampe. (*Trichostomum vaginans* Sull.; *D. lineare* (Sw.) Lindb.; *D. tortile* var. *vaginans* Grout). Gametophores erect, usually simple, about ½ in. tall; base of scales ovate, concave, margins narrowly recurved; sterile gametophores terete with closely appressed scales; perichaetial scales sheathing; seta ½–1½ in. long; sporangium smooth, brownish, somewhat zygomorphic, erect or inclined; basal membrane short. Late fall and winter. On sandy soil. Fairfield Co.

Ditrichum pallidum (Schreb.) Hampe. (*Trichostomum pallidum* Hedw.). Erect and simple or with erect branches from a creeping base; scales erect-spreading, twisted when dry, lance-subulate, costa long-excurrent; antheridia in buds below the perichaetium; seta yellow, twisted; sporangium reddish-yellow, irregularly sulcate when dry, ovoid-cylindric; peristome reddish. Early summer or spring. On soil in fields and woods. Clarke, Franklin, Greene, Hocking, Lake, Lawrence.

5. CERÁTODON Brid.

Light yellowish-green, radiculose below, branching by slender innovations; sporangium sulcate when old, lid conic; peristome single with a short basal membrane, teeth split nearly to the base.

Ceratodon purpurascens (Hedw.) Jenn. (*C. purpureus* Brid.; *Mnium purpureum* L.; *Dicranum purpurascens* Hedw.). Densely cespitose, green above and brown below, ½ in. or more tall; scales linear, costa strong, percurrent or excurrent, margins revolute; seta ¾–1½ in. long,

reddish-purple, twisted; sporangium erect, becoming horizontal when old, curved, strumose; calyptra cucullate; antheridial gametophores more slender. May and June. Common on dry soil.

6. DICRANÉLLA Schimp.

Densely cespitose or gregareous, mostly small, sparingly radiculose; scales slender, giving the moss a silky appearance, crowded above more distant below, costa percurrent or excurrent, apical portion usually grooved; seta erect, usually twisted; peristome teeth two or three-cleft; our species unisexual.

1. Costa wide, not well-defined at the base; seta yellowish..... 2
1. Costa narrow, sharply defined; seta red..... 4
2. Costa broad to the shoulder of the scale, then tapering to the apex; sporangium strumose.....*D. cerviculata*
2. Costa tapering gradually from the base; sporangium not strumose..... 3
3. Sporangium erect and actinomorphic.....*D. fitzgeraldi*
3. Sporangium somewhat cernuous.....*D. heteromalla*
4. Scales entire; sporangium cernuous, twisted to the right.....*D. varia*
4. Scales serrulate or denticulate; sporangium erect or inclined to the left, *D. rufescens*

Dicranella heteromálla (Dill.) Schimp. (*Bryum heter omallum* Dill.; *Dicranum heteromallum* Hedw.). Cespitose, simple or forking, ¼–1½ in. tall; scales secund, lance-subulate, grooved, faintly denticulate toward the apex, costa to ⅓ the width of the scale at the base; seta ½–1 in. long, flexuous, twisted to the left; sporangium oblong-ovoid, slightly curved, dark brown, when dry bent to one side just below the mouth, increasingly furrowed with age; peristome red, teeth bifid; beak inclined. Autumn. Common in hilly regions. Fairfield, Franklin, Lake, Lawrence, Logan, Summit.

Dicranella heteromalla var *strícta* Br. & Sch. Scales spreading at less than a 45 degree angle; seta longer and more flexuous than in the preceding species. Lake Co.

Dicranella heteromalla var. *orthocárpa* Hedw. Sporangium erect and actinomorphic, becoming furrowed and curved with age. Lake Co.

Dicranella fitzgeráldi Ren. & Card. (*D. heteromalla* var. *fitzgaraldi* Grout). Yellowish-green mosses with usually simple gametophores; scales crowded, erect-spreading, somewhat secund, lance-ovate at the base, subulate, grooved, denticulate near the apex; seta yellowish-red, dark brown when old; sporangium erect, actinomorphic, oblong, almost smooth when dry, not constricted below the mouth. On soil Not yet reported from Ohio but is found in western Pennsylvainia near our border.

Dicranella cerviculàta Schimp. (*Dicranum cerviculata* Hedw.; *Dicranella pusilla* (Hedw.) E. G. Britt.). Yellowish-green mosses with simple gametophores, not more than ½ in. tall; scales erect-spreading, sometimes secund, base ovate, half-clasping, only slightly denticulate, costa excurrent; seta yellowish, flexuous, to ½ in. long; sporangium short-oval, light brown, curved, strumose, irregularly ribbed when dry; lid long rostrate-subulate. Lesquereux reports this species as "very rare" upon the sides of ditches in the cranberry marshes of northern Ohio.

Dicranella vària (Hedw.) Schimp. (*D. rubra* (Huds.) Lindb.; *Dicranum varium* Hedw.; *Anisothecium rubrum* Lindb.). Densely gregareous to cespitose, bright green to yellowish-green, gametophores branching, erect or ascending, usually not more than ½ in. tall; scales erect-spreading, usually somewhat secund, lanceolate, gradually subulate, grooved, margins recurved, only slightly denticulate, costa percurrent; seta reddish, glistening, ascending or erect, twisted to the right, to ½ in. long; sporangium reddish-brown, oblong-ovate, slightly curved, smooth, constricted below the mouth; peristome teeth purplish, cleft to the middle; lid long-rostrate. Autumn or winter. Wet clay soil. This is a widely distributed species, but is not yet reported from Ohio.

Dicranella rufescens (Dick.) Schimp. (*Anisothecium rufescens* Lindb.) Cespitose, reddish to yellowish-green, redder when dry, less than ⅓ in. tall, usually simple; scales pellucid, few, plane, linear-lanceolate, gradually narrowed, slightly denticulate toward the apex, costa percurrent; seta red, twisted toward the left, about ¼ in. long; sporangium dark red, ovoid-globose, erect, actinomorphic, mouth wide; operculum large, conic-rostrate, apex oblique; calyptra cucullate. Summer or fall. Bare moist soil. Not yet reported from Ohio.

7. RHABDOWEÌSIA Br. & Sch.

Small, densely cespitose mosses with 5-angled, branched stalks, radiculose below; scales dense, decurrent, crisped when dry, plane, costa ending below the apex; seta light yellow, erect; sporangium erect, 8-striate, actinomorphic, annulus none; operculum long-oblique rostrate; calyptra cucullate.

Rhabdoweisia fúgax (Hedw.) Br. & Sch. (*Weisia fugax* Hedw.). Usually dark green, ½–½ in. tall; scales linear-lanceolate, acute to acuminate, somewhat concave, crisped when dry, faintly denticulate near the apex; seta ⅛ in. or less in length; sporangium oval, wide-mouthed, brownish, peristome teeth abruptly subulate, papillose. Usually in crevices in sandstone. Spring. Lake, Lawrence.

8. ONCÓPHORUS Brid. (*Cynodontium* Br. & Sch.).

Scales sheathing, ascending to squarrose, long-acuminate to subulate, margins recurved, crispate, never falcate-secund, costa distinct; seta erect; sporangium zygomorphic in our species, strumose, almost smooth when dry, annulus indistinct; peristome of 16 teeth, united at the base, divided to the middle; operculum obliquely rostrate; calyptra cucullate.

1. Scales gradually lanceolate from an ovate base.....*O. virens*
1. Scales abruptly subulate from an obovate base.....*O. wahlenbergii*

Oncophorus vírens (Ws.) Brid. (*Dicranum virens* Hedw.; *Bryum virens* Sw.). Robust, cespitose, branching, 2–3 in. tall, bright green above, brown tomentose below; scales smooth, entire or slightly serrate, somewhat crispate, costa excurrent; antheridia sessile below the perichaetium; seta yellow, about 1 in. long; sporangium dark reddish-brown, arcuate. Wet rocks and stony ground. Late summer and autumn. Lake Co.

Oncophorus wahlènbergii Brid. (*Cynodontium virens* var. *wahlenbergii* Sahimp.). Cespitose, branching, 1–1½ in. tall, tomentose below; scales strongly crispate, point flexuose, costa excurrent; seta yellow or reddish, ½ in. long; sporangium short, ovoid, often horizontal, curved; peristome teeth divided below the middle. Not reported.

9. DICRÁNUM Hedw.

Large mosses, thickly tomentose below; scales unusually falcate-secund, lanceolate to lance-subulate, margins plane in the upper half, not thickened, ours with a narrow semiterete costa; sporangium often strumose, annulus present; teeth red, cleft to the middle; calyptra cucullate; our species unisexual.

1. Scales transversely undulate 2
1. Scales not transversely undulate 5
2. Upper cells of the scales longer than broad, porous 3
2. Upper cells of the scales shorter or irregular, not porous 4
3. Scales recurved with spinulose teeth at the margins and back of the costa; setæ clustered ..... *D. polysetum*
3. Scales with saw-like teeth, almost smooth at the back of the costa; seta solitary ..... *D. bonjeanii*
4. Scales lanceolate, tapering, not papillose ..... *D. bergeri*
4. Scales ovate, broadest at ⅓ the distance from the base, suddenly subulate, papillose above ..... *D. spurium*
5. Upper cells longer than broad, porous ..... *D. scoparium*
5. Upper cells not porous 6
6. Scales distinctly serrulate above, papillose at the back 7
6. Scales entire or serrulate near the apex only, smooth or nearly so 8
7. Small; scales spreading, costa ending in the apex ..... *D. montanum*
7. Larger; scales falcate secund, costa often excurrent ..... *D. fuscescens*
8. Scales fragile, usually broken at the apex, entire ..... *D. viride*
8. Scales not fragile, toothed at least at the apex 9
9. Costa not excurrent, scales strongly crisped when dry, distinctly toothed near the apex ..... *D. flagellare*
9. Costa excurrent, scales slightly or not at all crisped, finely serrate ..... *D. fulvum*

Dicranum polysètum Swartz, Schw. (*D. undulatum* Ehrh.; *D. rugosum* Brid.). Loosely cespitose, branched, up to 5 in. tall, glossy; scales long-acuminate, wide at the base, sharply serrate in the outer half, inner half recurved, strongly secund; a gray tomentum over the stalks; setæ copper-colored; sporangium cernous, arcuate, lid with a long subulate rostrum. On soil. Fall. No reports.

Dicranum bonjeànii DeNot. (*D. palustre* LaPyl.). Loosely cespitose, branched, 2–3 in. tall, glossy; scales dense, only slightly secund, long-tapering, lanceolate, finely serrate, slightly undulate, costa narrow; sporangium slightly cernuous, arcuate, slightly striate, yellow; lid long-subulate. Late summer. On wet soil. Ashtabula, Fairfield, Lake.

Dicranum bèrgeri Bland. (*D. schraderi* Web. & Mohr.). Densely cespitose, yellowish-green; scales appressed, sub-secund, lanceolate, obtuse at the apex, undulate, sharply dentate on the outer half and back, costa not reaching the apex; sporangium obscurely striate; seta pale. In bogs. There is no specimen in the herbarium although it is listed as common in Beardsley's catalog.

Dicranum spùrium Hedw. Densely cespitose, branched, 1–1½ in. tall, scales dense, distinctly undulate, slightly secund, serrate at the edge and on the back, lanceolate, broad-ovate at the base, costa subpercurrent, perichaetial scales tubulose; seta solitary, 1 in. long, slender, yellowish-red; sporangium arcuate, cernuous, strumose, striate when dry, red at the mouth. Spring. On rocks and sand. No definite reports.

Dicranum scopàrium (L.) Hedw. (*Bryum scoparium* L.). Loosely cespitose, ½–2½ in. tall, yellowish to dark green; scales dense, long and slender, acuminate, concave, not undulate, serrate in the upper one-fourth, strongly secund, with 4 lamellæ on the back; seta single, reddish, glistening; sprangium reddish-brown, arcuate; operculum with a long curved point. On soil, logs and stones in the woods. Late summer and fall. Champaign, Clarke, Fairfield, Hamilton, Holmes, Hocking, Knox, Lake, Lawrence, Licking, Logan, Ross.

Dicranum flagellàre Hedw. Densely cespitose, erect, 1–1½ in. tall, deep green, radiculose below; scales somewhat falcate-secund, gradually lanceolate, involute to near the apex, serrate at the apex, costa percurrent, the upper scales often with slender flagellate branches in their axils; sporangium erect, cylindrical, actinomorphic, striate, slightly curved when dry; tips of the teeth hyaline; lid long-rostrate. Summer. Decaying wood and bases of trees. Champaign, Clarke, Fairfield, Franklin, Lake, Licking, Montgomery.

Dicranum montànum Hedw. Densely cespitose, light green, erect, ¼–½ in tall; scales secund or spreading, much crisped when dry, linear-lanceolate, concave, serrate near the apex, papillose on the back, basal cells brownish; seta single, erect, about ½ in. long; sporangium yellowish, plicate, oblong-cylindrical; teeth cleft nearly to the base; lid long-rostrate. Early fall. Rotten wood and tree trunks. Champaign, Lake.

Dicranum fuscèscens Turn. Cespitose, yellowish-green, 1½–2 in. tall, tomentose; scales dense, narrowly lanceolate, concave, entire or slightly dentate, costa percurrent or excurrent, to ½ the width of the scale at the base, variable in margins and surface; seta single ½–¾ in. long, light yellowish-brown, sporangium erect, oblong-oval, striate when dry, hypophysis short and tapering, lid with a point as long as the sporangium. Autumn. On rocks, wood, or base of tree. Lake, Logan.

Dicranum víride (Sull.) Lindb. Densely cespitose, light to dark green, ¼–¾ in. tall; scales dense, spreading, narrowly lanceolate, concave, entire, minutely serrate at the tip, costa percurrent, crisped when dry; sporangium oblong, erect or slightly curved when dry. Summer. On wood. Champaign, Clarke.

Dicranum fúlvum Hook. (*D. interruptum* Br. & Sch.). Silky, light green cespitose mosses, about ½ in. tall, brown radiculose below; scales dense, linear-lanceolate, not crisped when dry, finely serrate in the outer portion, secund, costa distinct, slightly excurrent; seta single, yellowish to darker, ½ in. long; sporangium erect, cylindrical, actinomorphic or slightly arcuate, brownish. Autumn. Non-calcareous rocks in moist woods. Clarke, Fairfield, Lake.

10. DICRANODÒNTIUM Br. & Sch.

Slender, cespitose, bright green mosses, densely radiculose below; scales somewhat distant, long, soft and silky; seta single, very slender; sporangium erect, cylindrical; hypophysis tapering; operculum with inclined beak almost as long as the sporangium; peristome inserted below the sporangium mouth, teeth cleft, striate; calyptra cucullate.

Dicranodontium longirôstre (Starke) Br. & Sch. (*Didymon longirostre* Starke; *Didymon denudatus* Lindb.). Scales long-subulate, caniculate, costa excurrent, entire, faintly toothed near the apex; seta curved; peristome red. Fall and winter. Usually on rocks. Fairfield Co.

11. BROTHÈRA C. Muell.

Densely cespitose, pale green, radiculose; scales erect-spreading, linear-lanceolate, subulate, almost entire, costa broad, filling the outer part of the leaf, abortive scales forming tufts in the axils of the upper scales; seta erect or slightly curved; sporangium smooth, erect; peristome teeth divided to near the base; calyptra large, cucullate, fringed at the base.

Brothera leàna (Sull.) C. Muell. (*Campylopus leanus* Sull.). Small mosses up to ⅛ in. tall, rarely branched; seta less than ⅛ in. long; sporangium oblong to elliptical, not stomate. No definite reports can be found of this species although R. S. Williams, Sullivant, and Lesquereux include Ohio in its range.

TORTULACEÆ.

Small to medium-sized, cespitose mosses; scales dense with a hyaline or colored base; sporangium erect or rarely inclined, actinomorphic or slightly curved; peristome usually of 16 deeply-divided teeth, sometimes wanting.

1. Scales widest in the lower half, usually acute 2
1. Scales widest in the outer half, obtuse, costa excurrent 9
2. Plants minute, cleistocarpous 3
2. Plants larger, with a lid 4
3. Margins strongly involute ..... *Astomum*
3. Margins slightly revolute ..... *Phascum*
4. Scales revolute, basal cells rarely hyaline, usually reddish or yellowish 5
4. Scales plane or involute, basal cells mostly hyaline 6
5. Peristome of 16 teeth, not twisted to the right, cleft ..... *Didymodon*
5. Peristome of 32 teeth, strongly twisted to the left, filiform ..... *Barbula*
6. Scale margins plane, peristome none ..... *Gymnostomum*
6. Scale margins involute, at least above 7
7. Peristome none, operculum deciduous, attached to the columnella, *Hymenostylum*
7. Peristome present 8
8. Margins strongly involute ..... *Weisia*
8. Margins plane, or involute only above ..... *Tortella*
9. Peristome wanting ..... *Pottia*
9. Peristome present, but may be very short 10
10. Peristome teeth 16, somewhat cleft; costa not excurrent, except in *D. plinthobius* ..... *Desmatodon*
10. Peristome teeth 32; costa strongly excurrent ..... *Tortula*

1. ÁSTOMUM Hampe.

Small, dull-green mosses; scales dense, lanceolate, entire, costa percurrent, or excurrent; sporangium usually immersed; calyptra cucullate.

1. Scales distinctly crisped when dry; sporangium globose, or subglobose..... 2
1. Scales scarcely crisped when dry; sporangium ovoid.....*A. nitidulum*
2. Branched, ¼–½ in. tall; sporangium globose, brown.....*A. crispum*
2. Usually simple, smaller; sporangium sub-globose, orange.....*A. sullivantii*

Astomum crîspum (Hedw.) Hampe. (*Weisia crispa* Mitt.; *Phascum crispum* Hedw.; *Systegium crispum* Schimp). Densely gregareous; lower scales smaller than the upper ones, linear-lanceolate, costa excurrent, papillose; seta shorter than the sporangium. Spring. Old fields. Not reported.

Astomum sullivántii Schimp. (*Systegium sullivantii* Jaeg.). Densely cespitose, dark green, erect. Autumn to early spring. Old fields. "Ohio" by Lesquereux.

Astomum nitîdulum Schimp. (*Systegium nitidulum* Jaeg.; *Phascum nitidulum* Muell.). A small rare species, differing from A. sullivantii mainly in smaller and having shorter scales, rarely crisped when dry; seta about ⅔ as long as the sporangium; lid obliquely rostrate. Reported from Ohio in H. C. Beardsley's catalog.

Astomum nitidulum var. *pygmaeum* Lesq. Minute, much branched; costa percurrent; sporangium orange, lid straight rostrate. Reported from "Central Ohio" in Mosses of Ohio, Lesquereux and James.

(These last two may both be variations of A. sullivantii, according to both Jennings and Grout).

2. PHÁSCUM (L.) Schreb.

Small mosses; ours with entire scales, papillose, ovate to lanceolate, costa excurrent in the uppermost; sporangium immersed or slightly excurrent.

Phascum cuspidàtum (Schreb.) Hedw. (*P. acaulon* L.). Simple or sparingly branched, ⅛–1/16 in. tall; upper scales crowded, lanceolate, acuminate, carinate-concave, margins revolute, costa excurrent; lower ones more distant, spreading, hyaline, papillose dorsally; sporangium globose, immersed, reddish-brown; seta erect or curved. Spring. On waste ground and fields. No definite reports, although Beardsley reports it as common.

3. PÓTTIA Ehrh.

Small simple mosses; scales broad; tufted above, carinate or deeply concave, papillose; seta erect, sporangium oval or cylindrical.

Pottia truncàta (Hedw.) Fuern. (*P. truncatula* Lindb.; *Gymnostomum trucatum* Hedw.). About ¼ in. tall, radiculose at the base; margins plane, crisped when dry, acute, costa distinct; seta ¼–½ in. long, yellowish; sporangium erect, actinomorphic, brownish; lid somewhat flattened. Autumn to spring. On wet soil. Reported from Ohio in Morgan's Flora.

4. WEÌSIA Hedw.

Small mosses with erect gametophores; scales erect-spreading, crisped when dry, elongate-lanceolate, upper larger than the lower, costa distinct, excurrent in a short point, upper surface papillose; seta long, usually erect; peristome small, teeth undivided, papillose.

Weisia virdula (L.) Hedw. (*Bryum viridulum* L.; *Mollia viridula* Hedw.). Dense, yellowish-green, about 1/16 in .tall; upper scales tapering gradually to an acute or acuminate point; seta 1/4–1/2 in. long, slender, yellowish; sporangium erect, ovoid, reddish-brown, grooved when dry; lid conic, obliquely-rostrate; spores orange, papillose. Spring. On bare soil. Clarke, Lawrence, Montgomery.

Weisia viridula var. *gymnostomoides* (Brid.) Braith. (*Hymenostomum microstomum* Aust.). Scales shorter and broader than in the preceding, peristome teeth short and truncate, lid with a shorter point. Reported from Ohio by H. C. Beardsley.

5. GYMNÓSTOMUM Hedw.

Unisexual, reddish-brown below, sparingly radiculose; scales tufted and larger at the top, erect-spreading, not crisped when dry, margins plane, costa ending below the apex, seta erect, long; sporangium actinomorphic, operculum early deciduous, calyptra cucullate.

1. Scales obtuse, ligulate..... *G. calcareum*
1. Scales acute or subacute..... *G. rupestre*

Gymnostomum calcàreum Nees. & Hornsch. (*Mollia calcarea* Lindb.). Dense, erect, branched, about 1/3 in. tall, yellowish-green; scales spreading, recurved, concave, obtuse; sporangium oblong, yellowish-brown, hypophysis tapering; rostrum oblique. On limestone rocks. Summer. Lake Co.

Gymnostomum rupêstre Schwang. (*Mollia aeruginosa* (Sw.) Lindb.). Larger than the preceding and not so densely cespitose; scales linear-lanceolate; sporangium ovate-oblong to sub-globose, yellowish or reddish-brown, seta reddish. Summer. On limestone. Lake Co.

6. HYMENOSTYLIUM Brid.

Densely cespitose, sparingly radiculose; scales dense, erect-spreading, not crisped when dry, but sometimes twisted, lanceolate, acuminate; seta erect, long; sporangium actinomorphic, operculum remaining attached to the columnella; lid oblique-rostrate; calyptra cucullate.

Hymenostylium curvirôstre (Ehrh.) Lindb. (*Gymnostomum curvirostre* Hedw.; *Weisia curvirostris* Muell.). Light, bright green, fragile, 1 in. or more tall; scale bases sub-clasping, margins entire, recurved, cells papillose; seta 1/4–1/2 in. long, castaneous; sporangium ovate, castaneous; spores yellowish. Late summer. Wet and usually calcareous rocks. Clarke, Lake.

7. DIDYMODON Hedw.

Mostly slender mosses; scales dense, lanceolate, scarcely crisped when dry, margins revolute, costa strong; sporangium erect, smooth, peristome of 16 teeth; operculum conic-rostrate; calyptra cucullate.

1. Lower portion of the plant reddish; scales acute or long sub-obtuse, *D. recurvirostre*
1. Lower portion of the plant brown; upper scales short and obtuse. . *D. tophaceus*

Didymodon recurvirôstre (Dicks.) Jenn. (*D. rubellus* Br. & Sch.; *Barbula rubella* Mitt.; *Weisia recurvirostre* Hedw.). Densely cespitose, branched, about ½ in. tall, red below; scales spreading, costa sometimes excurrent in a short point, upper scales papillose, basal ones almost transparent; seta red, about ½ in. long; sporangium cylindrical-oblong; peristome reddish, teeth filiform. Late summer and autumn. Moist stones. Champaign, Clarke.

Didymodon tophàceus (Brid.) Jur. (*Trichostomum tophaceum* Brid.; *Barbula longifolia* (Dicks.) Lindb.; *Barbula tophaceæ* Mitt.). Branching, about ½ in. tall, brown below; scales spreading, a tuft of short, blunt scales at the tip, costa never excurrent; seta erect, slender; sporangium oblong-ovate. Limestone soil.

8. TORTÉLLA (C. Muell.) Limp.

Densely cespitose, yellowish-green, brownish radiculose below; scales spreading to recurved, crisped when dry, elongate to linear-lanceolate, margins involute to plane, entire, undulate, costa ending at the apex or excurrent; seta red, erect; peristome of 32 teeth, sinistrorsely wound, papillose; calyptra cucullate.

1. Scales abruptly mucronate with excurrent costa, hermaphroditic. . *T. humilis*
1. Scales long-acuminate; unisexual 2
2. Scales straight, rather rigid, mostly broken . . . . . *T. fragilis*
2. Scales twisted, crisped when dry, less fragile . . . . . *T. tortuosa*

Tortella hùmilis (Hedw.) Jenn. (*T. caespitosa* (Schwaeg.) Limp.; *Tortula caespitosa* Hook. & Grev.; *Tortula humilis* Brid.; *Bryum humilis* Hedw.). Loosely cespitose, branched, ⅛–¼ in. tall; scales oblong to linear-lanceolate, margins plane or slightly undulate, erect-spreading, costa excurrent, cuspidate, a triangular patch of hyaline cells at the base; seta copper-colored, erect, ½–¾ in. long; hypophysis tapering; lid long-rostrate; calyptra cucullate; peristome single of 32 teeth, filiform. Summer. On soil and bases of trees. Champaign, Franklin, Lake.

Tortella tortuòsa (L.) Limp. (*Barbula tortosa* Web.f. & Mohr.; *Tortula tortosa* Ehrh.). Branched, green above; scales crowded near the apex, linear-lanceolate, spreading, tapering, long-acuminate, costa excurrent; seta reddish to paler above; sporangium cylindric, lid long-rostrate, oblique. On rocks. Not reported.

Tortella frâgilis (Drumm.) Limp. Similar to the preceding, but smaller and more slender; scales long-acuminate, slender, and the tips of all except the youngest usually broken off. Summer. Not reported.

9. BÁRBULA Hedw.

Yellowish-green to brownish, forked; scales erect-spreading, linear-lanceolate, margins mostly revolute, costate, basal cells colored; seta erect; peristome sometimes rudimentary or none, teeth 32, filiform, dextrorsely twisted; operculum conic-rostrate; calyptra cucullate.

1. Scales gradually tapering to an acuminate point, brownish-green..*B. acuminata*
1. Scales obtuse, not tapering gradually; often mucronate, yellowish-green.... 2
2. Perichaetial scales sheathing, convolute.....*B. convoluta*
2. Perichaetial scales not differing perceptibly from the others....*B. unguiculata*

Barbula acuminàta Hedw. (*B. fallax* Hedw.). Loosely cespitose, brownish often reddish, fastigially branched, ½–2 in. tall; scales rather distant, spreading to recurved, margins revolute to beyond the middle, entire, costa strong, ending below the apex, perichaetial scales sheathing at the base; seta erect, slender, red; sporangium oblong-cylindric; operculum long-rostrate. Late fall to spring. Soil and rocks in limestone regions. Lake, Montgomery.

Barbula convolùta (Huds.) Hedw. Densely cespitose, branching, ⅓–1 in. tall; scales erect-spreading, crisped when dry, oblong to linear-lanceolate, concave, margins crenulate, costa strong, usually ending below the apex, sometimes minutely excurrent; seta light yellow to reddish; sporangium erect, reddish-brown, narrow oblong-cylindric. Spring. On soil in limestone regions. Reported from Ohio by Lesquereux.

Barbula ungulàta (Huds.) Hedw. Densely cespitose, branching, ½–1 in. tall; scales erect-spreading or somewhat recurved, spirally twisted when dry, oblong-lanceolate, mucronate, costa strong, basal cells yellowish-pellucid to hyaline; seta erect, ½–1 in. long, red, slender; sporangium erect, oblong-cylindric. Late fall to spring. On soil and rocks. Fairfield, Lake, Montgomery.

10. DESMÁTODON Brid.

Small, slender, branched mosses; scales papillose; seta erect, elongated; sporangium erect, cylindrical; peristome irregularly cleft, short basal membrane very inconspicuous; lid long-rostrate, thick, oblique; calyptra cucullate.

1. Scale margins plane, bordered by light cells.....*D. porteri*
1. Scale margins recurved..... 2
2. Costa excurrent in a long, smooth arista.....*D. arenaceus*
2. Costa not excurrent, scales mucronate.....*D. plinthobius*

Desmatodon oblongifòlius Schwaeg. (*D. arenaceus* Sull.; *D. ohioensis* Schimp.; *Didymodon arenaceus* Lindb.). Gregareous, yellowish-green, radiculose at the base; scales tufted at the top, erect-spreading, crisped when dry, blunt, costa strong, margin crenulate, upper cells papillose; seta castaneous; sporangium dark-castaneous; peristome yellowish to reddish, teeth split to near the middle only. Spring. Sandy soil and rocks. Fairfield.

Desmatodon plinthòbius Sull. & Lesq. (*Tortula plinthobius* (Sull. Broth.; *Barbula subcarnifolia* C. Muell. & Lindb.). Scales obtuse, costa strong, arista as long as the remainder of the scale; sporophyte similar to the preceding genus; sporangium oblong to nearly cylindrical, peristome minute, pale. Rocks. Fairfield.

Desmatodon pôrteri James (*Tortula porteri* (Jas. & Aust.) Broth.). Minute mosses; scales brownish-green, tapering, bluntly acute; sporangium oblong, erect, teeth divided nearly to the base; seta orange. Spring. On rocks. Clarke.

11. TÓRTULA Hedw.

Robust plants, green to brown; scales oblong, larger near the tip of the gametophores, costa strong; sporangium cyclindrical, peristome of 32 teeth, twisted towards the left, papillose; operculum conic, oblique-rostrate; calyptra cucullate, covering half of the sporangium.

1. Cells of the scales smooth, awn smooth..... *T. mucronifolia*
1. Cells of the scales papillose, awn rough, hyaline at the tip, colored below..... *T. ruralis*

Tortula ruràlis (L.) Ehrh. (*Bryum rurale* L.; *Barbula ruralis* Hedw.). Loosely cespitose, light green above, brown below, 1–2 in. tall; scales dense at the apex of the stalk, more distant below, recurved-squarrose when moist, appressed when dry, entire, reflexed, costa excurrent into the rough awn; peristome teeth long, membrane ½ the height of the peristome; seta reddish at the base, lighter above. Spring. On rocks and sterile soil. Erie Co.

Tortula mucronifòlia Schwaeg. (*Barbula mucronifolia* Br. & Sch.). Loosely cespitose; scales ovate to oblong, reflexed, costa excurrent into a smooth point; sporangium ovoid-cylindrical; basal membrane almost as long as the teeth; operculum conic, elongated. Summer. Reported by Lesquereux.

LEUCOBRYACEÆ.

Dense tufts of whitish to glaucous-green mosses, spongy when moist, brittle when dry; scales of three layers of cells, tubular above, costa covering most of the scale; operculum conic-rostrate; calyptra cucullate.

1. LEUCOBRYUM Hampe.

Unisexual; scales crowded; sporangium more or less arcuate, strumose, 8-striate; peristome of 16 teeth or of 8 teeth divided almost to the base, united at the base into a tube.

1. Scales large, tufts 2 in. or more deep; sporangium arcuate, strumose, *L. glaucum*
1. Scales small; tufts ½–¾ in. deep; sporangium nearly erect, and slightly or not at all strumose..... *L. albidum*

Leucobryum glaùcum (L.) Schimp. (*L. vulgare* Hampe.; *Dicranum glaucum* Hedw.). Scales bristle-tipped, wide and clasping at the base, outer part rolled; seta erect, single, castaneous, sporangium decidedly arcuate and striate, distinctly strumose. Autumn. In moist woods on rocks and soil. Champaign, Fairfield, Fulton, Holmes, Lake, Portage, Seneca, Stark.

Leucobryum álbidum (Brid.) Lindb. (*L. minus* Hampe; *Dicranum albidum* Brid.). A smaller species which Dixon describes as a subspecies of L. glaucum; scales more crowded, with the tubular portion of the scale scarcely as long or often much shorter than the ovate base. Late spring and early summer. On wood or soil. Champaign, Fairfield, Lawrence, Sandusky.

ENCALYPTACEÆ.

Cespitose branched mosses, bright green above, brown radiculose below; scales dense, bordered, twisted when dry, costa strong, dorsally papillose and toothed, basal cells hyaline or colored, smooth, upper cells papillose; seta erect, slender; sporangium cylindric, actinomorphic; calyptra completely enclosing the sporangium.

1. ENCALYPTA Schreb. Hedw.

Only one species of this family has been reported from Ohio.

Encalypta ciliàta Hoffm. (*Leersia ciliata* Hedw.; *Leersia laciniata* Hedw.). Loosely cespitose, about 1 in. tall; scales apiculate, margins plane above, recurved below, costa excurrent or ending near the apex; calyptra fringed with narrow lanceolate teeth; peristome of 16 teeth; autoicous. Late summer or fall. Reported from Ohio by Lesquereux.

FISSIDENTACEÆ.

Minute to large mosses, gregareous or cespitose, light to dark green, reddish radiculose below; scales 2-ranked, vertically placed, the base sheathing, with an often decurrent dorsal lamina, usually costate, cells rounded-hexagonal; seta erect or curved; peristome, when present, red and simple, teeth usually cleft; calyptra conical, smooth.

1. Dorsal laminæ narrow; stalk bulbiform at the base; peristome wanting, ... *Bryoxiphium*
1. Dorsal laminæ usually wider; stalk not bulbiform at the base; peristome present 2
2. Terrestial or submerged, not floating ..... *Fissidens*
2. Aquatic, floating, filiform ..... *Octodiceras*

1. BRYOXÍPHIUM Mitt. (Eustachia Brid.).

Gregareous, flat, usually simple mosses; scales imbricated, linear-lanceolate, glossy, bordered, costa percurrent, perichaetial scales long-acuminate; calyptra cucullate; unisexual.

Bryoxiphium norvegicum (Brid.) Mitt. "Sword Moss." Yellowish, ⅓–1 in. tall; scales short-acuminate; sporangium obovate, yellow, red at the mouth, inclined; seta thick; operculum red at the base, persistent; peristome none. Shaded vertical sandstone faces. Fairfield Co.

2. FÍSSIDENS Hedw.

Simple or sparingly branched mosses; scales strongly winged, linear-obovate to lance-obovate; antheridia in gemmiform buds; annulus narrow, teeth cleft; calyptra cucullate.

1. Scales not bordered 2
1. Scales bordered 5
2. Costa excurrent in an apiculus ..... *F. taxifolius*
2. Costa ending at or below the apex 3
3. Scales entire, apex obtuse ..... *F. obtusifolius*
3. Scales serrulate or crenulate 4
4. Scales apiculate; seta terminal; costa to near the apex ..... *F. osmundoides*
4. Scales more rounded; seta lateral; costa ending some distance below the apex ..... *F. subbasilaris*
5. Costa none; very small mosses ..... *F. hyalimus*
5. Costa distinct 6
6. Border only on sheath ..... *F. exiguus*
6. Border quite or nearly to the apex 7
7. Border of narrow elongated cells; costa to the apex 8
7. Border of paler cells of the same shape as the others; costa ending below the apex 9
8. Border confluent with the costa, forming a blunt point ..... *F. bryoides*
8. Border very narrow, almost disappearing below the apex ..... *F. incurvus*
9. Plants less than ¾ in. tall; cells indistinct ..... *F. cristatus*
9. Plants ¾–4 in. tall; cells of the scales distinct ..... *F. adiantoides*

Fissidens taxifòlius (L.) Hedw. (*Hypnum taxifolius* L.). Light green, branching at the base, less than ½ in. tall; scales crowded, oblong-ovate, obtuse, crenulate, costa strong; seta lateral, flexuous, reddish, sporangium usually curved, inclined or pendulous, oblong, brown; teeth cleft to below the middle. Late fall and winter. On moist soil in woods. Champaign, Clarke.

Fissidens hyalìnus Wils. & Hook. Minute, pale simple mosses; scales in 3–5 pairs, oblong-lanceolate, acute, entire; seta terminal, erect; sporangium oblong, erect or oblique; operculum rostrate, calyptra covering the beak. Clay banks and rocky ledges. Rare. Hamilton, Lake.

Fissidens bryoìdes (L.) Hedw. (*Hypnum bryoides* L.). To ¼ in. tall; scales oblong, entire, costa strong; antheridia in axillary pediculate buds; seta terminal, erect, slender, copper-colored, less than ½ in. long; sporangium erect, short, oblong-oval; teeth split ⅔ their length. Late fall. Shaded pots in the greenhouse. Franklin, Lake.

Fissidens obtusifòlius Wils. Minute, erect, simple mosses; scales entire, oblong, upper ones ascending, cells rounded, costa ending below the apex; seta erect, brownish; sporangium erect, oblong-ovate, brownish; operculum very short-rostrate; peristome yellowish-pellucid. Autumn. Wet rocks. Clarke, Fairfield, Hamilton.

Fissidens incúrvus (Starke) Schw. Simple mosses, ¼–½ in. tall; scales oblong-lanceolate, apiculate, or bordered to near the apex; seta reddish, ¼–¾ in. long; sporangium ovoid, cylindrical, curved; antheridia in basal buds. Late autumn. On rocks. Clarke Co.

Fissidens incurvus var. *minutulus* (Sull.) Aust. (*F. minutulus* Sull.). Minute, green erect, simple; scales in 3–7 pairs, narrowly oblong-lanceolate, margin entire or undulate, costa ending below the apex; seta reddish; sporangium usually actinomorphic and erect. Autumn. Damp rocks in the shade. Clarke, Franklin, Hamilton, Lake, Perry.

Fissidens exíguus Sull. (*F. incurvus* var. *exiguus* Aust.). Light green, very small; scales in 3–5 pairs, upper ones the largest, dorsal laminæ narrowing to none at the base, costa ending below the apex; sporangium erect or inclined, oblong-oval, reddish-yellow. Early fall. Rocks in ravines and streams. Franklin Co.

Fissidens cristàtus Wils. (*F. decipiens* DeNot). Slender mosses, branching at the base, ½–1 in. tall; scales numerous, imbricated, ovate-lanceolate, laminæ somewhat decurrent; seta lateral, brown; sporangium oblong, tapering, constricted below the mouth, nearly erect, golden-brown; teeth cleft into very narrow divisions. Winter and early spring. Soil, stones, or bases of trees. Champaign, Franklin, Muskingum.

Fissidens adiantoìdes (L.) Hedw. (*Hypnum adiantoides* L.). Light green, slender, branching; scales serrate, oblong-lanceolate, border often indistinct, laminæ ending abruptly at the base; seta lateral, reddish-brown, flexuous, ½–1 in. long; sporangium horizontal to erect; antheridia axillary. Winter. Clay soil, rocks, and bases of trees. Champaign, Clarke, Franklin, Lawrence.

Fissidens osmundoìdes (Swartz.) Hedw. (*Dicranum osmondoides* Swartz). Dark green, erect, branched, tomentose below; scales oblong-lanceolate obtuse, apiculate, serrulate near the tip, non-bordered, laminæ not decurrent, costa to near the tip; seta terminal, reddish-brown, ¼–½ in. long; sporangium darker, horizontal or inclined, mouth wide, hypophysis tapering; operculum with a long straight beak. Summer. On ground or tree trunks in swamps. Champaign Co.

Fissidens subbasilàris Hedw. Green, with a brown tomentum below, ¼–¾ in. tall; scales oblong, obtuse, apiculate, serrulate near the apex, costa ending some distance below the apex, laminæ large, rounded at the base; seta lateral, yellowish-brown, reaching to the top of the gametophore; sporangium oblong-cylindrical, nearly erect, smooth, brown, hypophysis tapering; peristome darker, teeth cleft to the middle, points slender; operculum with an oblique point half the length of the sporangium. Late autumn. Trees and rocks. Champaign, Clarke.

3. OCTODÌCERAS Brid. (*Concomitrum* Mont.).

Slender, floating, branched mosses; scales distant, linear-lanceolate; seta short; sporangium small; calyptra mitrate, operculum conic-rostrate.

1. Much branched, 2–6 in. long.....*O. debilis*
1. Sparingly branched, less than ½ in. long.....*O. hallianus*

Octodiceras debilis (Schw.) Jenn. (*O. julianus* Brid.; *Concomitrum julianum* Mont.; *Fontinalis juliana* Savi.; *Fissidens julianus* Schimp). Flaccid, blackish-green below; scales long, spreading, non-bordered, inferior laminæ not reaching the base, costa vanishing below the apex; seta fragile, shorter than the sporangium; teeth degenerate. In streams and swamps on wood and stones. Summer. Reported from Ohio by Lesquereux.

Octodiceras halliànus (Sull. & Lesq.) Jaeg. & Sauer. (*Concomitrium hallianum* Sull. & Lesq.; *Fissidens hallianus* Mitt.). Dark green, in loose, floating tufts; scales narrowly linear, entire; seta longer than the sporangium; sporangium obovate, pale; teeth not divided; calyptra cucullate. On partially submerged wood and stones in streams and swamps. Not yet reported.

BIONOMIC NOTES ON SOME PARASITES OF ACHATODES ZEÆ HARRIS (NOCTUIDÆ, LEP.) AND PHLYCTAENIA TERTIALIS (GUEN.) (PYRALIDÆ, LEP.).

W. V. BALDUF.*

Beyond the mere description of species nothing has been written concerning most of the parasites of the elder borer (*Achatodes zeæ* Harris) and the elder leaf tier (*Phlyctaenia tertialis* (Guen.). The present article is an account of observations made at Oak Harbor, Ohio, and Urbana, Illinois in 1927 and 1928, on the parasites reared from the above Lepidoptera. One or more individuals of most species developed under the direct observation of the writer, hence no doubt remains regarding the hosts to such forms. As for the other species no other insects except these moths were present in sufficient numbers to have been the hosts of the parasites reared miscellaneously from elder.

Parasites From *Achatodes zeæ*.

The elder borer is a conspicuous white Noctuid larva with black tubercles. It is common in succulent elder (*Sambucus*) stems from May to July. When full-grown, the larva forsakes its old burrow and bores anew into dry stems of elder or large weeds. Pupation occurs there chiefly during June and July, and the adult issues through exits prepared in the side of the stems by the larva. The flattened disc-shaped eggs are inserted under the edges of partially loose bark on old elder stems from middle to late summer. The species winters in the egg stage, and the young larvæ probably hatch early in May at Urbana. Any parasites attacking the egg, larva, or pupa need to penetrate more or less woody tissue of the elder to reach the host.

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The witer wishes here to thank Messrs. Aldrich, Cushman, Gahan, Greene and Morrison for their services in determining the Diptera and Hymenoptera discussed in this paper.

Parasites have been reared to date only from the larval and pupal stages of the borer, and all were species of Ichneumonoidea and Chalcidoidea. The larval stage is attacked by the larger number of these.

HYMENOPTERA.

Microplitis gortynæ Riley.

Microplitis gortynæ Riley, Vipionidæ, a species about 2.5 mm. long with a black body and yellowish-brown legs, is the most abundant parasite attacking the elder borer, and was also reared from the common stalk borer (*Papaipema nitela*) by Dr. C. R. Neiswander at Oak Harbor. The specimens described by Riley (1) were reared from cocoons from *Achatodes* (*Gortyna*) *zeæ* received by him from Dr. Hoffmeister in Iowa. Its habits are similar on both hosts. The parasite lives internally in the host. While emerging, the mature larva secured leverage on the inside structures of the host or on the bodies of its cohabitants. That such leverage is useful is indicated by the failure, in some instances noted, of the last one or more of the larvæ to escape when the body of the caterpillar has become flabbid due to the issuance of most of the parasites. Passage through the muscles of the host is affected by pushing and gyrating with the head applied to the body wall of the host, but the outer chitinous layer is penetrated and torn by the action of the extended mandibles and maxillæ.

The newly emerged larvæ remain attached to the host by means of the posterior bulb-like process on the abdomen that is left inserted in the exit hole and is distinguished from the rest of the body by a definite constriction. Distribution of a mass of larvæ from one host is quite general over the abdominal and posterior thoracic regions, and chiefly on the dorsal and lateral aspects. Being contiguous during cocoon-spinning, the individual cocoons of a mass become more or less inter-twined, but some are isolated. The host is usually overcome by the emerging parasites shortly before it would have left its first burrow to enter the characteristic place for pupation. This fact is confirmed by Hawley (2) who says "the larva of the parasite apparently leaves the grub (*Gortyna immanis*) just as the latter is about to pupate." Hence, there is only enough space between the caterpillar and the walls of its burrow to accomodate the cocoons of the parasites.

In making the cocoons, the larvæ stand out perpendicular to the host. The strands of silk from the pair of labial pores are not always fully united before they become hardened from exposure, and then form a broad flat line. At first a jumble of silk is formed by the larva around its cauda. On this basis, the larva produces series of small loops, row upon row, much as a stocking is knit, and with considerable industry as indicated by loops formed at the rate of 43 per minute, in one instance. Fresh silk strands applied to the bare body of a neighboring larva fail to adhere. The inner, continuous layer of the cocoon is made after the larva relinquishes its hold on the host. The cocoon is of the type commonly described as ribbed, the ribs consisting of longitudinal, more or less parallel, rounded external ridges of silk, When the continuous layer of the cocoon is begun, the larva engages chiefly in vibrations lengthwise, and concentrates on rather definite spaces which therefore receive more silk than the intervals between the ribs. These thinner intervals are built up by rapid, short transverse brushings of the face on these areas. The ribs thus develop due to a preponderance of time and material given to these alternate spaces, which also appear as convexities on the outer surface on account of the pressure outward by the larva during the spinning process.

Emergence of the larvæ was observed at Oak Harbor in 1927 on June 24 and 25 from *A. zeæ*, and on Aug. 9 from *P. nitela*. In 1928 the first cocoons at Oak Harbor were found on June 29, and larvæ in the act of spinning were discovered occasionally during the next two weeks. Of 206 *A. zeæ* caged, 23, or 11.16% were parasitized by *M. gortynæ*. The number of cocoons per individual host ranged from 10 to 39, but the majority bore 26 to 32, and the average for all was 25.3 per borer. Of 65 Urbana caterpillars, only one was killed by this species, 23 cocoons being present in this case. Hawley (2) found 80 cocoons "with a single skin" of *Gortyna immanis*. The borer above that yielded only 10 parasites was found to have left its original burrow and had formed its pupal cell before it was overcome. This seems to indicate the effect of difference in number of parasites on the vigor of the host. Usually the host is killed in its original tunnel.

New cocoons of *M. gortynæ* obtained from *A zeæ* in June and July of 1927 and dissected in September and February, show that the species winters as a larva in its cocoon and that

only one generation develops in a year. Some of the cocoons kept in a warm laboratory yielded adults in March (1928), whereas others obtained by Dr. C. R. Neiswander of Ohio from *Papaipema nitela* in August (1927) and kept in an outdoor insectary at Oak Harbor, produced adults in June (1928), a few being alive on June 29. Hawley (2) found adults coming from their cocoons in the field in New York on June 11, 1915, and in the laboratory observed them parasitizing "partly grown larvæ" of *Gortyna immanis* Gn. at that time." And later in the summer the cocoons were again found (Hawley) both in the cages and in the field." Henry Bird (3) reports this parasite attacking also *Papaipema nebris* Guen. at Rye, N. Y.

The four hosts cited above,—*A. zeæ*, *G. immanis*, *P. nitela* and *P. nebris* are closely related forms of Noctuidæ and have similar life cycles which favor the attack of *M. gortynæ*, both hosts and parasite having one generation per year, and their larval stages run parallel during June and July. According to the writer's observations in Ohio, the first adult parasites to issue find *A. zeæ*, whereas later comers have the larvæ of *P. nitela* available for their progeny, the latter species of host appearing in the larval state one to several weeks later than *A. zeæ*.

Microbracon lutus (Prov.) (*lixi* Ashmead).

Provancher's (4) original description gives no bionomic data for this Braconid, and later records concerning it are few. These are condensed from Musesbeck's summary (20) as follows: "Bred from *Lixus scrobicollis* Boh. on *Ambrosia trifida*" by Dr. A. D. Hopkins; *Papaipema nebris* Gr. (H. Bird, Rye, N. Y.); two reared from *Ambrosia* at Manchester, Mass., by the U. S. Bureau of Entomology European Corn Borer Laboratory. All are females. He adds that "but little material of this species in addition to the types, has been seen." The adult is 3.5 to 4.0 mm. long, with color yellowish-brown, and antennæ, propodeum and tarsi darker. The mature larva dissected from its cocoon in the winter is 3.5 mm. long and 2 mm. wide at the middle, depressed, more nearly flat below than above, and ovate in outline with ends broadly rounded. The head is small and the mouthparts reduced in the usual manner of Ichneumonoidea. The abdominal segments, ten in number, are mostly longer than the thoracic segments. The

color is bright lemon-yellow. The cocoons have a slightly convex surface when massed together, but when occurring singly, or by twos or threes, are more strongly convex. In outline they are somewhat irregular, but roughly elongate-oval, and when in masses conform to the shape of the surroundings. Their deep-brown color renders them inconspicuous in the dark-walled burrows of their hosts. One entire mass of 13 cocoons is one inch long. When only a few are present they may be isolated.

Six adults reared from cocoons obtained from Paris, Illinois, were five females and one male. A dead male was removed from its cocoon at Oak Harbor in June 1927. In the summers of 1927 and 1928 in Ohio, masses of empty cocoons were discovered occasionally, always in the deserted burrows of *A. zeæ*.

The immature larvæ have been found to be ectoparasitic on advanced caterpillars of *A. zeæ*. They were first seen on June 27, 1927 at Oak Harbor when three individuals occurred feeding on an almost full-grown host. On June 29, two of these were each just over 2 mm. long, whereas the third measured 5 mm. in length and 1.5 mm. in maximum diameter. The bodies of these, and of all others of this species taken subsequently on this host, bore polka dot-like spots, perhaps subskeletal fat specks, on the body. These persisted until after the cocoons were spun, but had disappeared by midwinter. The larvæ are fairly agile, occur here and there on the host, and promptly crawl under cover when exposed to the light. The larvæ insert their mandibles into the host's exoskeleton and appear to suck liquids for food. At times, upon seizing the host with the madibles and pulling vigorously, the hold was suddenly broken, causing the parasite to snap back with a jerk. It is likely that a small hole is thus prepared to which the mouth is then probably applied in feeding. The parent parasite may paralyze the host at the time of oviposition, inasmuch as the hosts observed, even when the parasite larvæ were small, never travelled from where they were first seen. The present host seemed to be dead although decay failed to exhibit itself during five days of observation in partly very warm weather.

By June 30 these parasite larvæ had grown to 3.7 and 5 and ⅝ mm. long, respectively, and the host was very flabby, although still bright in color. The weather was hot and humid, and growth rapid. On July 1, the largest larva had spun its

cocoon, and the smaller larvæ had become mature, being 5 mm. long, and began to make their cocoons on that date. As an instance of superparasitism, it should be stated that this particular caterpillar was also parasitized internally by larvæ of *Microplitis gortynæ*, and by a dipterous maggot which at first worked externally, but spent most of the stage inside the borer feeding on the larvæ of *M. gortynæ* which failed to mature. The fly died in its puparium.

On June 30, 1928, another *A. zeæ* larva, 30 mm. long, or near maturity, was found parasitized externally by three larvæ of this species at Oak Harbor. Again there was a marked discrepancy in size among them. The host also retained its fresh white appearance while the parasites fed upon it, and although incapable of locomotion, was still alive. As in the above instance, this caterpillar was superparasitized, containing 20 larvæ of *M. gortynæ*, which, however, emerged and formed their cocoons on July 2. By this date the *Microbracon lutus* larvæ had grown to two or three times their size of June 30. Two made their cocoons on July 3 and the third on July 5, growth being very rapid.

At Urbana on May 30, 1928, an *A. zeæ* larva halfgrown was taken in elder and bore on its back a speckled external parasite then slightly more than 2 mm. long. It spun its cocoon on June 3 on several others of its kind about one inch, as in the three instances described above, from the now collapsed host. There was no evidence of superparasitism in this instance, and the dilapidated state of the host was probably caused chiefly by feeding of the several parasite individuals that had reached maturity on it before May 30. It was probably quite small when parasitized. According to this instance, *M. lutus* therefore began activity earlier by about a month at Urbana than at Oak Harbor.

These Oak Harbor and Urbana cocoons of 1928 still contained lemon-colored larvæ on December 31, 1928, when they were placed indoors and one of the adults issued under forced conditions in early February, 1929. Inasmuch as the mass of cocoons from Paris, Illinois also was occupied by such larvæ in February, it is obvious that *M. lutus* passes the winter in the larval state in its cocoons formed from latter May to early July at Urbana and Oak Harbor, respectively. Because the host is not in the larval condition until early May (Urbana) and late May or early June (Oak Harbor), and further because

the parasite larvæ attack advanced borers, it is clear that pupation and adult emergence of the parasite occur in May or June. The female possesses a robust ovipositor which, it may be inferred, penetrates the green succulent elder stems which at that time have tender walls rendered thin by the feeding of the larger borers probably present at the time of oviposition. There is thus only one generation in a year, which, like that of *Microplitis gortynæ*, coincides with that of their mutual host.

Epiurus pterophori (Ashmead).

One specimen of the Ichneumonid *Epiurus* (*Pimpla*) *pterophori* was reared from a burrow of *Achatodes zeæ* at Reno, Ohio, near Oak Harbor. This species, described by Ashmead in 1889 (5), had previously been reared in March by Mr. Albert Koebele from a *Pterophorus* (Pterophoridæ, Lepidoptera) living in stems of *Baccharis pilularis*, in Los Angeles, California. On June 21, 1928, the writer found in the hollow elder stem the much shrivelled remains of an *A. zeæ* caterpillar readily distinguishable by the spurs on the anal tergite. One inch from the dead host a partition of silk at right angles to the length of the burrow had been constructed by the parasite then still in the larval state. The other end of the cocoon consisted of the end of the host's tunnel. This cell, 16 mm. long and as wide as the burrow, was lightly faced on its whole area with silk that was scarcely visible. The host had been overcome while rather small, as indicated by the very short burrow it made before it was killed. The larva pupated on June 22. Development in the pupal state was retarded by six days of cool weather, but the adult condition was reached on July 2, or in a transformation period of 10 days. In escaping from its cell, the adult broke down most of the brown partition of silk at the end, but instead of crawling out in the burrow of the host and issuing to the outside through the exit of the borer, it prepared its own circular exit two mm. in diameter through the woody stem of the elder and close to its pupal chamber. This species probably has alternate hosts, and was obviously rare on the elder borer. The adult is almost 16 mm. long, including the ovipositor, and has a black body, while the legs are mostly shiny brown.

It was possible to study the larval and pupal stages of this insect carefully in life, hence descriptions of these are given herewith. The mature larva is 10 mm. long, with a maximum

width of 2.2 mm.; the body tapers to a blunt posterior and the 13 postcephalic segments are very distinct and quite uniform in length except the first longer and the last smaller. The color is yellowish-white, and the surface minutely and densely tuberculate. The top of the head has four longitudinal black bands, the outer members being strap-shaped and about five times wider than long; the middle two are triangular with their outer edges curved. The antennæ are minute, yet distinct, conical, and two-segmented, each segment ringed black at its base. On what seems to be the lower edge of the labrum is a transverse row of coarse black teeth, the lateral members very short, the mesal one the longest, with the intermediate two intermediate in size. The three larger teeth are thick, robust, rounded at the base and taper to a blunt tip. The mandibles are heavily chitinized, brown, forming a triangular figure arising at the sides of the labrum. The prothorax bears a pair of brown, almost crescent-shaped patches on its humeral angles. These are oblique, and extend cephalo-ventrad from the hind edges of the segment. The thorax bears one pair of spiracles on the front lateral edge of the middle segment. The abdomen has a pair of spiracles on each of the first eight somites, and are situated just above the lateral lobes at the anterior edge of the segment.

The newly transformed pupa is white, 11. mm. long, and 2 ⅛ mm. in maximum width which is at the thorax. The ovipositor arises from the venter of the sixth segment (not counting the propodeum or the petiole), and bends around the tip of the abdomen, and forward to the middle of the fourth abdominal segment, its entire length in contact with the body. This condition suggests that of the ovipositor in the adults of the chalcid family Leucospidæ. The second abdominal segment is longer than one, and three to seven. Each of segments two to six has two sharp pointed spurs on each side below the spiracles, one dorsad of the other, the lower one situated near the lower edge of the tergites. Segments five to seven also bear a transverse row of six shorter, finer spurs, three on each side of the dorsal part of the ovipositor. Arising from the hind edge of the last tergite and near the ovipositor are four much larger, heavier spurs, all directed slightly caudad. The head and thorax are lemon-yellow, but the abdomen is white like the larva, except the tip of the abdomen. The body is bare excepting the hairs or spurs already described, and the

propodeal furrow is margined with prominent, well-defined ridges rounded above and diverging slightly beyond the middle and more sharply thereafter.

Amblyteles spp.

Mr. Cushman identified eight specimens of *Amblyteles* as *A. scelestus* (Cress.), *A. consignatus* (Cress.), and *A. caeruleus* (Cress), and in his report (a letter of Sept. 24, 1928) adds, "Further study convinces me that these specimens represent one end of a very widely variable species, ranging from nearly black to brilliant blue or green and with great variation in sculpture." They vary in length from 11.5 mm. to 14 mm. The bionomic data obtained in the present writer's observations confirm Cushman's conclusion. All these species were reared from the chrysalis stage of *Achaodes zeæ*, and within the same season. The first adult found was removed fully formed from its host on May 11, 1928. Mr. E. G. Kelsheimer had collected the elder stem containing this individual at Paris, Illinois in mid-April, and the material had been kept indoors in the meantime. On May 10, 1928, the writer gathered eight entire pupæ of *A. zeæ* in old elder stems at Urbana, and from May 15 to 22, adults of these *Amblyteles* spp. issued indoors. In addition to these, two specimens were obtained from Oak Harbor pupæ of this moth, one on July 23, and another on July 26, 1928.

Considering the known facts about the life history of the host, it seems that *Amblyteles* spp. parasitize the nearly or quite mature borers. The host pupates in the usual place and is overcome by the parasite before the moth state is reached, the parasite possibly becoming a pupa before winter. These parasites seem therefore to have one generation annually adjusted to hosts with one cycle per year.

Cresson described *A.* (*Ichneumon*) *consignatus* (6) from one male taken at Ridings, W. Va.: *A.* (*Ichneumon*) *scelestus* (7) from Illinois, and *A.* (*Ichneumon*) *caeruleus* (7) from the eastern states. The writer's material was as follows: two *A. scelestus* from Oak Harbor, Ohio; and the rest of the material representing *A. consignatus* and *A. caeruleus* was obtained at Urbana, or at Paris, Illinois. Most of these are the latter form.

Eupteromalus viridescens (Walsh).

Mr. A. A. Girault (8) summarized the known host records of *Eupteromalus viridescens*, but his account perhaps contains

some confusion in host relations because this species and *Hypopteromalus tabacum* Fitch are regarded by him as one, whereas, Mr. A. B. Gahan (9) considers them distinct forms. However, it has always been reared as a hyperparasite, mostly from cocoons of *Apanteles* and their relatives. The writer had it quite commonly from the cocoons of *Microplitis gortynæ* Riley and *Microbracon lutus* (Prov.), both primary parasites of the elder border, *A. zeæ*. Harry Walker reared it from *M. gortynæ* cocoons on *Papaipema nitela* at Oak Harbor on June 25, 1928. In February 1928, the writer had it from *M. lutus* cocoons from Paris, Illinois, and dissected dead specimens from the same host at Oak Harbor in June 1928. As many as four dead individuals occurred in one cocoon. Holes through the thinner, lateral walls of the cocoons show that the hyperparasites sometimes pass from one cocoon to its neighbor, rather than penetrate the tougher outer cover. However, they can issue only through this upper cover, the other surfaces being in contact with the burrow of the borer. Exit holes found on August 30, 1928, in new cocoons made in June and July by both *M. gortynæ* and *M. lutus* were probably made by this species. In this lot was found one dead specimen of this hyperparasite with its ovipositor inserted into a cocoon of *M. gortynæ* in August. *E. viridescens* obviously goes through more than one cycle in a year. The adult is about 2 mm. long, the body is metallic black and green, and the legs yellowish-brown.

Miotropis clisiocampæ Ashm.

Old elder stems collected by E. G. Kelsheimer at Oak Harbor in December 1927, contained one dead chrysalis of *A. zeæ* occupied by *Miotropis clisiocampæ*. A single, small irregular hole in the side was obviously made by some emerged adults of this Eulophid (Chalcidoidea) parasite. The chrysalis, which occupied the usual position of this host in the old elder stem, still retained the dead bodies of 105 *M. clisiocampæ* in various states of development between pupa and adult. Some solid matter of the host remained. Because there is only one generation of *A. zeæ* annually, this individual host had been parasitized by *M. clisiocampæ* not later than June or July of 1927, and the parasites very likely issue normally sometime before winter from this host.

During the summer of 1928 two additional lots of this species came to hand at Oak Harbor from *A. zeæ*, presumably from two individuals of the host. On and about July 18, 145 parasites appeared in a cage containing only pupæ of this borer, and on or near August 20, 279 specimens were taken from another cage in which the same stage of this host was present. When these cages were discontinued, one pupa of *A. zeæ* was found to have a small emergence hole in its side and contained remnants of small chalcids. All the *M. clisiocampæ* obtained from the three chrysalises are females.

Mr. Gahan, in his report following the study of this parasite material, states that this Eulophid is "a common parasite upon various lepidopterous pupæ." Ashmead described it (20) from four female specimens bred June 28, 1891, by Prof. A. D. Hopkins from *Clisiocampa americana* on apple at Morgantown, W. Va. Doctor L. O. Howard (21) identified it from the same host and state, at Frenchcreek, where it had been reared by Mr. F. E. Brooks. Doctor A. L. Quaintance (22) cites Fiske (23) who obtained it from the pupa of the same moth in New Hampshire. Phillips, Underhill and Poos (24) had it from one pupa of *Diatraea zeacolella* Dyar which "yielded about thirty specimens" of this parasite. All of these issued through five emergence holes. The adults in alcohol measured 1.3 to 2 mm. in length. All are dark, polished, with the scutellum and metathorax light brown or yellowish, and the legs and part of the antennæ pale yellow. The dorsal outline of the abdomen (female) is almost round.

Habrocytus sp.

This Pteramalid species was taken in small numbers only from cages containing the pupæ of *A. zeæ* and the cocoons of *Microplitis gortynæ*. Both sexes were bred between August 23 and 28, 1928 at Oak Harbor. It resembles *E. viridescens* but is larger with darker legs, and the female abdomen tapers to a sharper point behind.

Eurytoma sp.

Two females of this species were taken alive in a cage of *A. zeæ* on July 11, 1928, at Oak Harbor. They are perhaps parasites, but their host in this case is unknown.

DIPTERA.

Aphiochaeta aletiæ (Comstock).

The remarkable habits of this Phorid have already been described by the writer (11)*. This fly is 2.5 mm. in length. The body is brown to black, and the legs vary in color from yellowish to deep brown. While dissecting old elder stems in February 1928, a dead *Achatodes zeæ* larva was discovered in its original feeding burrow, and one-half inch from the exit hole. The body had shrivelled and collapsed, and its black color indicated again that a plant disease caused its death. Chiefly within two inches of these caterpillar remains lay 73 empty puparia, which, judged by determined specimens of this stage, were positively those of *A. aletiæ*. The dried condition of the borer nevertheless made it possible to notice that the mandibles were widely spread apart, much as the anus of the specimen previously described (11) had been permanently distended. In another instance, two mature caterpillars of *A. zeæ*, from Urbana, which were killed and blackened by a fungous or bacterial disease bore mature but small maggots on their backs on July 9, 1928. The maggots compared structurally with those described heretofore (11), and were no doubt this species of Phoridæ. The present evidences therefore confirm those cited in the former article and show *A. aletiæ* to be a scavenger. The maggots appear habitually to feed internally in the *A. zeæ* larvæ, and seem not to enter by breaking the body wall but utilize the natural apertures, the anus or perhaps the oral opening, as places for entrance.

Because elder borers killed by this disease were abundant during the latter part of June and early July, 1928, it is probable that the good number of *A. aletiæ* reared then developed on these unhealthy caterpillars. In 1927 (11), the single adult obtained emerged on July 13. The first adult in 1928 appeared in the Oak Harbor cages on July 16, and this stage was present during the rest of the month. The peak of emergence was reached on August 2, when most of the borers had transformed to moths. The flies were still at hand in fair numbers on

*In the earlier paper referred to above occurs the name *Aphiochaeta* sp., which is identical with *A. aletiæ* named in the same. Specimens reared after the paper was submitted for publication enabled Mr. C. T. Greene of the U. S. Nat. Museum to determine the species, which was not possible with the single, imperfect specimen sent at an earlier date to Dr. Aldrich.

August 10, and probably issue till about the middle of this month.

Aphiochaeta (*Phora*) *aletiæ* was described by Comstock (12) as a true parasite of *Alabama* (*Aletia*) *argillacea* Hbn., obtaining it in abundance from the chrysalis stage. The evidence for this view on the habit of the larva was, however, not conclusive.

Parasites from *Phlyctaenia tertialis* Gn.

This leaf tier has two generations per year both at Oak Harbor and Urbana. The winter is spent as mature larvæ in the hollow or pithy stems of old elder or weed stalks standing or lying in proximity to the feeding places of this stage. In April and May to June they transform to pupæ and the adults probably first oviposit in June. The eggs are placed in small masses on the under sides of elder leaves, the latter being tied and rolled later by the larvæ. When about to pupæ, the larvæ become deep pink. The first generation caterpillars, like those of the second which hibernates, forsake the leaves and descend into the stalks of dry elder or weeds to pass the chrysalis period. Oviposition by the second generation occurs from mid-July to September, and mature larvæ in hibernation were found as early as latter July.

HYMENOPTERA.

Meteorus loxostege Viereck.

The type of this Braconid was reared (13) from *Loxostege sticticalis*, the beet webworm, on April 14, 1910 by H. O. Marsh at Rocky Ford, Colorado, and a few specimens of this parasite were bred (14) from the same host in Ontario, Canada by E. H. Strickland. Further host records are given by Muesebeck (15): *Pyrausta futilalis*, College Park, Maryland, reared by A. B. Gahan; *L. sticticalis*, Nebraska, and Maxwell, New Mexico;" one labeled as reared from a 'Nelumbians pyralid' ," but bearing no locality label; one from Woods Hole, Massachusetts; and Muesebeck reared two specimens from *Pyrausta nubilalis*, Watertown, Massachusetts. The present writer has it from *Phlyctaenia tertialis* Gn. Hence, to date the species is known definitely only from Pyralid larvæ of the subfamily Pyraustinæ. It was easily the most plentiful hymenopterous parasite of *P. tertialis*. Most of the 48 specimens taken were reared indoors

during January, February and March of 1928, from elder stems collected at Urbana on October 29, 1927 and February 11, 1928, but the species is also fairly common at Oak Harbor. The host larvæ of both generations became mature and entered quarters for pupation before their *Meteorus* parasite larva issued from them. None were ever found to have pupated before the parasite came out to spin its cocoon. In the instance of the overwintering host larvæ, emergence of the parasite larvæ was delayed until spring, so that *M. loxostegei* passes the winter at Urbana as a larva, presumably of advanced size, in its host. Whenever a post-mortem examination was made, the exit hole of the parasite was located on the seventh abdominal segment behind the third pair of prolegs and chiefly on the side or venter. In a lot of material collected on May 12, 1928, a few parasites had already issued and formed their cocoons when found, and a number of others kept indoors after the above date appeared from the caterpillars by May 22. The cocoons of *Meteorus* are formed in that of the host beside the shrunken body of the latter. The cocoons are about 6 mm. long, and have a maximum diameter of 2 mm. They are light-brown in color, the form is elongate-oval, and the walls moderately thin. The adult is a plain light-brown insect 4 to 5 mm. in length.

New *P. tertialis* larvæ were not available on elder in nature until about the middle of June, hence the adult *M. loxostegei* obtained from the above material before May 31 after a pupation period of nine days in the laboratory had developed earlier than its kind out-of-doors.

An adult female reared from its cocoon on July 9, 1928 at Oak Harbor was placed in a cage of *P. tertialis* larvæ which also were reared, but from the egg stage. This female, introduced here at intervals from July 10 to 14, had died on the latter date. The leaf tiers in the cage were then 7 to 20 mm. long, or from one-third grown to almost mature. Four cocoons of this parasite were found here between July 24 and 27. Adults issued on August 1, 3, and 6, two on the first date. The pupation period was therefore approximately eight to ten days and development from egg to adult required about three weeks indoors in the summer. Every specimen obtained from this cage and elsewhere proved to be a female, and inasmuch as a generation of adults was reared as the progeny of an unfertilized female, *M. loxostegei* is parthenogenetic as far as present observations show. Muesebeck (15) reports that this mode of

reproduction also occurs in *Meteorus autographæ* Mues. However, the male of this latter species is known. *M. loxostegei* presumably attacks its host when, or before, it is half-grown to enable the parasite larva about ten days to mature before its host can pupate. The host generations overlap freely, and three or more generations of the parasite may develop annually.

Apanteles sp.

Apanteles sp. was reared in small numbers, but its empty or hyperparasitized cocoons were usually found commonly both at Urbana and Oak Harbor. Dr. L. O. Howard (16) describes *A. delicatus* whose habits are similar to those of *A.* sp. The cocoons, which are almost 4 mm. long, and yellowish-white, occur singly and fastened to the surfaces of elder foliage. The parasite was never reared from this caterpillar, and inasmuch as the host does not remain by the parasite, or on the leaf at all, there is no direct evidence now at hand to prove the host-parasite relation believed to exist here. But no other insect was ever seen to inhabit elder foliage, and the leaves bearing the cocoons invariably bore the typical injury caused by *P. tertialis* larvæ. Whether the caterpillars from which *A.* sp. issued recovered from the attack, fell to the ground, or attached themselves to die elsewhere was not learned. Only the isolated parasite cocoons on the top or the lower side of the leaf, usually one per leaf, could be found. Adults were reared on and about August 2, 1928 at Oak Harbor, and in the week preceding and the week following this date, the cocoons reached the highest number in the season.

Specimens of this species were also obtained in January from Urbana cages containing, when these were first established, mature, hibernating larvæ of *P. tertialis*. Remnants of this species were found beside a small cocoon in an old hibernaculum of this host in an old elder stem. Two perfect adults of this species were removed from their cocoons in which they died after completing their exit holes. Many empty cocoons were also seen in such hibernacula at other times. This shows therefore that *A.* sp. is carried into the winter cells of the host as an internal parasite, whereas in the summer it leaves the caterpillar before the latter goes into its pupation position which is the same as the winter quarters.

Hoplocryptus spp.

Two undescribed species of this Ichneumonid genus were obtained in small numbers. The adults are 8 to 10 mm. long, not including the ovipositor. The slightly smaller species has white pro- and mesocoxæ, whereas the hind coxæ are light brown, which is the color of this segment on all legs of the larger species. In both species the head, apices of the abdomen, and some of the thorax are black. The color is otherwise mainly yellowish-brown or darker; the tarsi and scutellum, and some areas on the head and prothorax, are creamy white.

One specimen of the first species was seen at Urbana in a laboratory cage on February 15, 1928 in its transparent whitish cocoon in the winter case of *P. tertialis* in elder collected on October 29, 1927. The adult appeared on February 29, 1928. Five other specimens were reared during the winter from similar elder material containing many *P. tertialis*. The four in the writer's possession are males. It was not observed whether their larvæ issue from the caterpillar or from the chrysalis of the host.

Two dead individuals of the second species were found lying beside their cocoons within the hibernation cell of a *P. tertialis*. Another was taken out-of-doors on May 24, 1928 in an old stem in the cocoon of this moth. The parasite was then in its larval stage, had issued only a short while before from a fresh chrysalis of *P. tertialis* (which winters as a larva), and was spinning its cocoon when found. The adult came from this cocoon about June 5. Another chrysalis of this moth, opened in the field in early June, contained a hymenopterous larva that filled its host completely. It may be that this was another of this *Hoplocryptus* sp. It failed to develop. These specimens were obtained at Urbana. One of the same species was reared by Mr. E. G. Kelsheimer at Oak Harbor on June 19, 1928 from a cage of old elder stems devoted to rearing *Achatodes zeæ*, but it is probable that this parasite came from a *P. tertialis*. These two species of moths are associated in such places in their larval and pupal stages. A total of nine specimens of this parasite was taken, four of which are females.

Phytodietus pulcherrimus (Cress).

Two females of this Ichneumonid, originally described from Connecticut in 1868 (6), were reared. It is black, and has all

regions of the body beautifully marked with bright yellow, which, on the abdomen, takes the form of narrow, segmental rings. The length is 7 mm., not including the ovipositor. They issued from elliptical cocoons about 10 mm. long, amber in color, and bearing a denser transverse band of light-brown at the middle. Both were in the mature larval state when found at Grays Siding (near Urbana) on May 13. On May 25 they had pupated (indoors) and were white with light-brown eyes. They were taken in old elder stems. One adult issued on June 8, and the other was fully developed in its cocoon on the same date. The elders contained empty chrysalises of *A. zeæ*, several mature noctuid larvæ of another species occupying deserted burrows of *A. zeæ*, and *P. tertialis*. Circumstantial evidence points to parasitism on larvæ of *P. tertialis*.

Phytodietus distinctus Cress.

Phytodietus distinctus Cress; first described in 1870 (6, vol. 3), measures 8 mm. in length not including the ovipositor and yas a plain black body, excepting the abdomen which is ringed hellow. The legs are mostly reddish-brown with the tarsi and hind tibiæ mostly brown. The cocoon closely resembles that of *P. pulcherrimus* above. The single specimen taken emerged through a subterminal hole in its cocoon on July 1, 1928. This species is a primary parasite of *P. tertialis*. The cocoon containing the immature parasite was found in the hibernaculum of this moth in an old elder stem at Reno, Ohio, late in June. It is probable that the parasite hibernates as an advanced larva within the over-wintering mature caterpillar.

Triclistus propinquus (Cress.).

The sides of the prothorax are deeply, broadly and obliquely grooved to receive the much swollen front femora. These features of the mesothorax are similar to those of the prothorax, but less so. The body is entirely black and the legs yellowish-brown. The length is 7 mm. Two males were reared from cages of elder stems containing *P. tertialis*. Both specimens of this Ichneumonid were obtained at Urbana, one on April 2, 1928 (indoors) from elder collected on February 11, and the other on June 21, 1928. The latter represents the normal date of appearance. The host is probably *P. tertialis*,

in as much as the first one was obtained before *A. zeæ* began its spring development as a larva. It was described (7) by Cresson from material taken in Colorado.

Sesioplex validus (Cress.).

Sesioplex validus (Cress.) (*Tryphon seminiger* Cress.), is represented in this series of parasites by a single male. It issued at Urbana on February 28, 1928 in a cage of old elder stems occupied by *P. tertialis* larvæ, on which it is probably parasitic. It is about 7 mm. long, its antennæ and body black. The front legs are entirely yellowish to reddish-brown, the middle legs the same except the tarsi which are ringed alternately white and black. The hind legs have the coxæ black, the trochanter joints black and brown, the femora mostly brown, the tarsi black, and each of the tibiæ with two black and two white rings. It is known in Connecticut (17), and the type material was obtained in Illinois (7).

Gambrus (*Cryptus*) *incertus* (Cress.).

This ichneumonid species was described (7) from Delaware. The writer took two males and a female. Its host relation was definitely determined by the discovery of the parasite larva in its cocoon formed on the remains of the larva of *P. tertialis* in its winter case in an old elder stem at Urbana. This condition existed on February 11, 1928 when the elder concerned was collected, hence the parasite hibernates as a larva, and if an endoparasite, issued from the host before winter. Its cocoon measures 8 mm. long, is deep brown, and bears very fluffy silk externally. Emergence was affected through a subterminal hole. The other came from an elder stem cage kept indoors in December, 1927, the elder material collected on October 29, 1927, at Urbana.

The male adult is 8 mm. long and the female slightly longer and more robust. The antennæ, head, thorax, and abdominal segments five to nine, are black; the rest of the abdomen and the legs, mostly, are reddish-orange. The apices of the hind femora and tibiæ, and the tarsal segments are black, excepting the third and fourth, and apical half of the second which are white.

Bassus (*Microdus*) *simillimus* Cress.

This Braconid species is represented by one female specimen found alive in a cage of old elder stems in the laboratory on February 10, 1928 at Urbana, Illinois, and is perhaps also a parasite in the larvæ of *P. tertialis*. Britton (17) states it is "on record as a parasite of *Eucosma strenuana* (Tortricidæ) and *Lixus scrobicollis* (Curculionidæ)."

It is of interest as pertaining to the habit relations of this parasite and the above hosts that all these host species spend much of their larval life under cover of folded leaves or in stems of plants. Cresson described it (21) from New Jersey, Pennsylvania and Illinois. Its head, antennæ, ovipositor sheaths, thorax, (excepting propodeum), most of the legs, and the abdomen are black. The propodeum and abdomen are pale sanguineous, and the tips of the hind tibiæ and tarsi are more or less fuscous.

Aenoplex nigrosoma Cushman?

This doubtfully determined individual was reared from the hibernaculum of a larva of *P. tertialis* on February 29, 1928 at Urbana. Its cocoon, which occupies a part of the cocoon of the host, is 6 mm. long, barely 2 mm. in maximum thickness and light grey in color. The adult issued from a hole near the end of the cocoon. The host was still a larva when the parasite grub emerged.

Eulimneria sp.

On May 15 and 30, 1928, respectively, two dead fragmentary specimens of *Eulimneria* sp. were removed from cocoons of *P. tertialis* collected on those dates from elder stems at Urbana. Here also the parasite cocoons are formed within the cells of the host larvæ. They have a length of more than 6 mm., the color is grey with a brownish tinge, and the adult issued through a terminal hole.

Gelis sp.

Records for this genus (Ichneumonidæ) indicate that the species are at least in part secondary parasites in the cocoons of *Apanteles* and similar forms. This undescribed species

measures 3.5 mm. in length and is rather slender. The color of the body is exceedingly variable from almost entirely fuscous to nearly wholly dull yellow, whereas the legs are usually mostly yellowish-brown. Seven winged and seven wingless specimens were reared in cages of old elder stems infested with *P. tertialis* larvæ during the winter of 1927-28 at Urbana. The cocoons of *Apanteles* sp. discussed earlier in this paper, and other Ichneumonid primary parasites of *tertialis* occurred in the cages, and it is supposed that *Gelis* sp. is a secondary parasite in one or more of these. The adult was one of the first species to appear after the establishment of the cage.

Eupteromalus viridescens (Walsh).

This Pteromalid is described more fully above as a secondary parasite from certain primaries on *Achatodes zeæ* (p. 10). Although not reared under direct observation, this is the only species of secondary parasite obtained that could have made the small holes seen in the cocoons of *Apanteles* sp. described herein and parasitic on *P. tertialis*. It was obtained commonly from elder stems in cages maintained during the winter of 1927-28 at Urbana.

Elasmus atratus Howard.

Dr. L. O. Howard (16) reared the type material of this species from *Apanteles hyphantria*, *A. delicatus*, and *Limneria valida*, all primary parasites of *Hemerocampa leucostigma*. The male has flabellate antennæ, and in both sexes the hind coxæ are very large and strongly compressed. Both sexes measure about 1.5 mm. long, and the bodies are chiefly black. Nine specimens were reared in a vial from the cocoons of the *Apanteles* sp. already discussed on page 16, and believed to be parasitic on *P. tertialis* and found very commonly on elder foliage at Oak Harbor. *E. atratus* issues from its host through a subterminal hole, and eight individuals developed from two of the *Apanteles* cocoons. Of the six specimens still at hand, four are females. Four of the six came from their host on August 6, and two on August 30, 1928.

DIPTERA.

Zenillia caesar (Aldrich).

Doctor Aldrich (18) described *Zenillia* (*Exorista*) *caesar* from specimens reared by Prof. Lawson Caesar from *Cacaecia* (*Archips*) *argyrospila* Walk. at Simcoe, Ontario, Canada. The summary of the records by Aldrich and Webber (19) gives the following additional localities or hosts of this Tachinid: *C. argyrospila*, Canyon City, Colorado, and Wenatchee, Wash. (in Walton's unpublished index); *Loxostege sticticalis* Linn., Greely, Colorado; *Pyrausta nubilalis* Hueb., West Medford and vicinity, Mass., and *Crambus trisectus* Walk., Lafayette, Ind. It is also known from New Mexico.

This species and *Nemorilla floralis* Fall., described below, are somewhat larger than the housefly, or 5.5-7.0 mm. long and moderately robust. The second antennal joint of *Zenillia* is much shorter than the third, whereas in *Nemorilla* this segment is nearly as long as the last. The color of both species is black and gray, and the bodies bristly.

Zenillia caesar proved to be second only to the Braconid, *Meteorus loxostege* Vier., numerically as a parasite of *P. tertialis*. Twenty-seven individuals were reared as follows: seventeen Urbana specimens forced under laboratory conditions from December 22, 1927 to March 8, 1928 from old elder gathered in October and February; beside these, four issued indoors on May 12, 15, 17 and 19, from leaf tiers collected in nature on May, 1928; August 10, 1928, one from the host taken on July 26; at Oak Harbor, one was reared on August 6, another on August 8, and two more on August 20, 1928. Observations on overwintered mature caterpillars of *P. tertialis* transported to indoor cages showed that the parasite larva issued always from the caterpillar of *P. tertialis*, and not from the chrysalis as noted in several instances of *Nemorilla floralis* below. *Z. caesar* spends the winter as at least a well developed maggot within its host. A considerable percentage of the host's hibernacula examined at Urbana in latter May already contained empty puparia beside the shrunken but still whitish remains of the host larvæ. This parasite probably has two or more generations each year.

Nemorilla floralis Fallen (*maculosa* Meigen).

On November 19, 1928, Dr. J. M. Aldrich informed the writer by letter that *Nemorilla floralis* Fallen "is now considered to be a prior name for *maculosa* Meigen." This species is referred to in the literature under various names (19, p. 5), and is recorded from both Europe and North America. Aldrich and Webber (19) redescribed it "from a long series of both sexes, from New England and Idaho to Cuba, the Virgin Islands, and Arizona. . . . . The species has a voluminous literature in Europe, and has been reared many times in the United States, always from larvæ of moths and butterflies. It is recorded also from Canada."

Twelve specimens of this Tachinid were reared by the writer from *P. tertialis* material in cages. Three of these are from Urbana, dated January 12, March 8, and May 17, 1928. The Oak Harbor specimens issued in 1928, as follows: August 8, two; August 9, three; August 20, four; and August 25, one. Two of the Oak Harbor series were obtained under direct observation from the chrysalis of the host, one of them pupating within the chrysalis of the host, and the parasite adult forcing its way out through the cephalic end of the chrysalis. In the rest of the instances, the host must at least have been a mature caterpillar, if indeed it had not already pupated at that time.

Gaurax dorsalis Lw.

This beautiful Chloropid (Oscinidæ) fly with its black and yellow body about 2 mm. long was bred in spring and summer from cages of elder stems occupied by the larvæ or chrysalises of *P. tertialis* at both Urbana and Oak Harbor. The larvæ were not seen in action, but judging by scattered records of the habits of its generic relatives, and by the general condition in which it was taken, *dorsalis* is probably a scavenger on the remains of other insects inhabiting the elder. Their food may have been the caterpillars killed by disease or the parasites, empty chrysalises of the moth, or even the discharged solids in the empty cocoons of the many parasites that developed on the elder leaf tier.

SYNOPTIC TABLE

Order	Family	Genus	Species	Relationship	Host or Food
Hymenoptera	Vipionidæ	*Microplitis*	*gortynæ*	Primary parasite	Larvæ of *A. zaæ* and *P. nitela.*
Hymenoptera	Braconidæ	*Microbracon*	*lutus*	Primary parasite	Larvæ of *A. zeæ.*
Hymenoptera	Braconidæ	*Meteorus*	*loxostegei*	Primary parasite	Larvæ of *P. tertialis.*
Hymenoptera	Braconidæ	*Apanteles*	sp.	Primary parasite	Probably larvæ of *P. tertialis.*
Hymenoptera	Braconidæ	*Bassus*	*simillimus*	Primary parasite	Probably larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Epiurus*	*pterophori*	Primary parasite	Larvæ of *A. zeæ.*
Hymenoptera	Ichneumonidæ	*Amblyteles*	spp.	Primary parasites	Pupa of *A. zeæ.*
Hymenoptera	Ichneumonidæ	*Hoplocryptus*	spp.	Primary parasites	Larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Phytodietus*	*pulcherrimus*	Primary parasite	Probably larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Phytodietus*	*distinctus*	Primary parasite	Larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Triclistus*	*propinquus*	Primary parasite	Probably larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Sesioplex*	*validus*	Primary parasite	Probably larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Gambrus*	*cryptus*	Primary parasite	Probably larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Eulimneria*	sp.	Primary parasite	Larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Aenoplex?*	*nigrosoma?*	Primary parasite	Larvæ of *P. tertialis.*
Hymenoptera	Ichneumonidæ	*Gelis*	sp.	Secondary parasite	Probably in cocoons of *Apanteles* sp. et al.
Hymenoptera	Eulophidæ	*Miotropis*	*clisiocampæ*	Primary parasite	Pupæ of *A. zeæ.*
Hymenoptera	Pteromalidæ	*Eupteromalus*	*viridescens*	Secondary parasite	Cocoons of *M. gortynæ and M. lutus.*
Hymenoptera	Elasmidæ	*Elasmus*	*atratus*	Secondary parasite	Probably *Apanteles* sp.
Hymenoptera	Pteromalidæ	*Habrocytus*	sp.	?	?
Hymenoptera	Eurytomidæ	*Eurytoma*	sp.	?	?
Diptera	Tachinidæ	*Zenillia*	*caesar*	Primary parasite	Larvæ of *P. tertialis.*
Diptera	Tachinidæ	*Nemorilla*	*floralis*	Primary parasite	Pupæ of *P. tertialis.*
Diptera	Phoridæ	*Aphiochaeta*	*aletiæ*	Scavenger	Diseased larvæ of *A. zeæ.*
Diptera	Chloropidæ	*Gaurax*	*dorsalis*	Probably scavenger	Various elder stem inhabiting insects.

Discussion.

Of the 26 species mentioned in the Synoptic Table (p. 240) 22 are Hymenoptera. 17 of these are Ichneumonoidea, 12 belonging to the family Ichneumonidæ, 4 are Braconidæ, and one is a member of Vipionidæ (Hym. Conn.). All, excepting *Gelis* sp., are primary parasites, three attacking the larvæ of *Achatodes zeæ*, one (*Amblyteles* spp.)— (regarded here as a single species)— the pupal stage of this host, and 12 have been found with practical certainty to parasitize the larval stage of *Phlyctaenia tertialis*. *Hoplocryptus* spp. (2 species) may issue from the chrysalis of this moth. Other species whose host relations are described in the table above as probable may later prove to inhabit the pupal stage also. The other five Hymenoptera belong to the superfamily Chalcidoidea, with various host relations as stated in the table. The host relations of *Habrocytus* sp. and *Eurytoma* sp. remain unknown.

Two of the four Diptera are probably scavengers, and the two Tachinidæ are parasitic, one issuing from the larva, the other from the chrysalis, of *P. tertialis*. Thus, 22 of the 26 species recorded herein are at least probable primary or secondary parasites on the two elder infesting moths, *Achatodes zeæ* and *Phlyctaenia tertialis*. Five belong to the *A. zeæ* complex, both the larval and pupal stages of this host being sheltered by elder stems, and 16 are associated with *P. tertialis* whose larval or most vulnerable stage lives exposed on plant foliage hidden only by the rolled leaves of the food plant.

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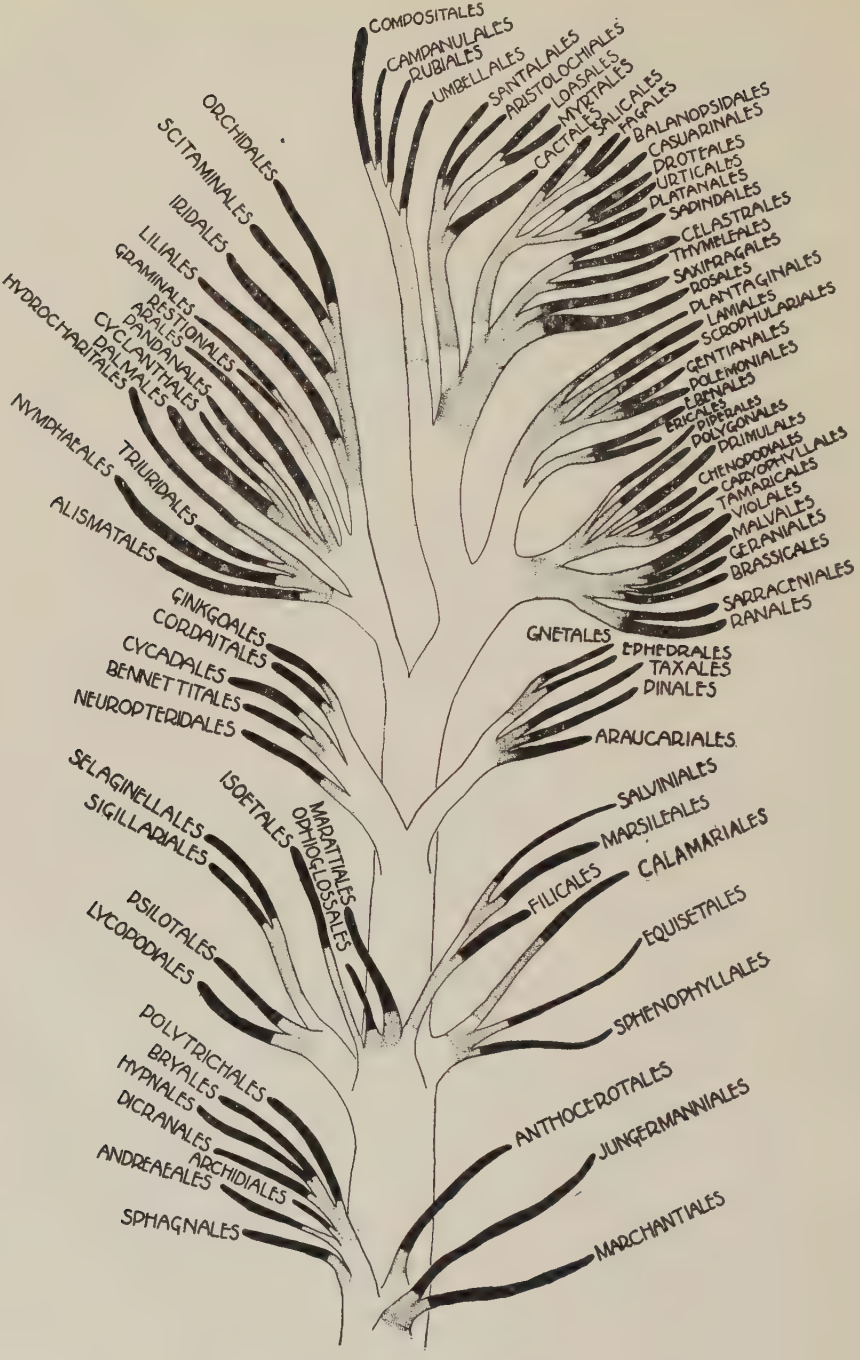
PRINCIPLES OF PLANT TAXONOMY, VII.*

JOHN H. SCHAFFNER.

Having considered the progressive stages of evolution and the correct sequence of the orthogenetic series, it becomes necessary to dispose of the fact of segregative characters thru which the present complex system of plant groups was brought about. It is evident that evolutionary progress is through individuals. If this were not the case, if the entire race evolved through a common property or impulse, then there would be no lower organisms left. For these would all have evolved to higher types long ago. The origin of the new individual or rather the new potentiality or group of potentialities does not alter the old which remain and perpetuate themselves just the same as before. This fundamental fact must be at the basis of any rational system of taxonomy. It must be recognized, however, that the same mutative change may take place many times in the same species or may also be repeated in any number of species or groups. Parallelism is very prominent in most plant groups. The progressions and parallelisms are easily discovered but the characters which are of a truly segregative value are often difficult to recognize. The true, phyletic system is, however, based on segregative movements, through which new and independent progressive lines are established. In the fourth paper of this series, the segregation into the great phyla was considered. The segregation will now be carried farther and the phyletic system of classification developed through to the orders. There are no criteria known for the delimitation of orders. They are simply the main phyletic branches of the classes and subclasses. In order to retain the "order" as a large branch or group an arbitrary numerical limit is set up and we thus say that ordinarily no class or subclass shall have more than seven, unless there is a very special reason for making more. This is a perfectly proper scientific procedure because it is the same kind of an exercise as the attempt to determine the number of large branches a tree may contain, or the number of large secondary branches in a still larger primary branch.


COMPOSITALES
CAMPANULALES
RUBIALES
UMBELLALES
SANTALALES
ARISTOLOCHIALES
LOASALES
MYRTALES
CACTALES
SALICALES
FAGALES
BALANOPSIDALES
CASUARINALES
PROTEALES
URTICALES
PLATANALES
SAPINDALES
CELASTRALES
THYMELEALES
SAXIFRAGALES
ROSALES
PLANTAGINALES
LAMIALES
SCROPHULARIALES
GENTIANALES
POLEMONIALES
EBENALES
ERICALES
PIPERALES
POLYGONALES
PRIMULALES
CHENOPODIALES
CARYOPHYLLALES
TAMARICALES
VIOLALES
MALVALES
GERANIALES
BRASSICALES
SARRACENIALES
RANALES
ORCHIDALES
SCITAMINALES
IRIDALES
LILIALES
GRAMINALES
RESTIONALES
ARALES
PANDANALES
CYCLANTHALES
PALMALES
HYDROCHARITALES
NYMPHAEALES
TRIURIDALES
ALISMATALES
GINKGOALES
CORDAITALES
CYCADALES
BENNETTITALES
NEUROPTERIDALES
GNETALES
EPHEDRALES
TAXALES
PINALES
ARAUCARIALES
SELAGINELLALES
SIGILLARIALES
ISOETALES
MARATTIALES
OPHIOGLOSSALES
SALVINIALES
MARSILEALES
FILICALES
CALAMARIALES
EQUISETALES
SPHENOPHYLLALES
PSILOTALES
LYCOPODIALES
POLYTRICHALES
BRYALES
HYPNALES
DICRANALES
ARCHIDIALES
ANDREAEALES
SPHAGNALES
ANTHOCEROTALES
JUNGERMANNIALES
MARCHANTIALES

Since the plant kingdom falls very distinctly into Thallophyta and Metathallophyta, the two groups will be considered separately and the charts indicating the probable relationships and comparative levels will also be given in two separate plates. The writer is under obligation to Professor Floyd A. McClure, of Lingnan University, Canton, China, who made the final draft of the accompanying diagram of the phyletic relationships of the orders.

SYNOPSES OF THE CLASSES, SUBCLASSES, AND ORDERS OF THE METATHALLOPHYTA

Phylum, Bryophyta.

I. Gametophyte with gametangia not imbedded in the thallus tissue; sporophyte not with intercalary growth between the sporangium and foot; sporangium not two-valved when a central columella is present.

A. Rhizoids unicellular; mature gametophyte thalloid or a stem-like frond with scales; sporangium without a central columella, without or with elaters. Hepaticæ.

1. Gametophyte a thalloid dorsiventral frond composed of several distinct tissue layers, mostly with air passages; sporangium rarely opening by 4–8 valves. *Marchantiales.*
2. Gametophyte a frond with stem and scales, or if flat and thalloid not composed of several distinct tissue layers; never with air passages; sporangium nearly always opening by 4 valves. *Jungermanniales.*

B. Rhizoids multicellular or septate; mature gametophyte not thalloid; nearly always stem-like and covered with scales; sporangium nearly always with a central columella, if not, then without elaters.

1. Gametophyte with a pseudopodium bearing the mature sporophyte; sporangium not with a complete columella, but with a dome-shaped cavity.
   a. Gametophyte gray-green, with two kinds of cells in the scales, narrow ones with chlorophyll and large ones without, but commonly with spiril fibrils; sporangium with an operculum. Sphagneæ. *Sphagnales.*
   b. Gametophyte dark colored, not with two distinct kinds of cells in the scales; sporangium splitting into 4 or more valves. Schizocarpæ. *Andreaeales.*
2. Gametophyte without a pseudopodium; sporangium nearly always with a complete columella, usually with an operculum and a well developed peristome of teeth. Odontocarpæ.
   (1). Sporangium without a columella, the sporogenous and vegetative cells commingled. *Archidiales.*
   (2). Sporangium with a definite central columella, which may, however, in rare cases be absorbed.
   a. Peristome teeth thin, developed in the ampithecium and derived from the cell walls of a single layer of cells, always transversely barred; sometimes entirely wanting.
      (a). Peristome single, composed of two layers of plates made by a deposit on the inner and outer sides of the original cell wall, rarely wanting; usually acrocarpous. *Dicranales.*
      (b). Peristome double or sometimes wanting, the plates of the outer side of the teeth mostly in two rows by a zigzag median line, the inner side of the teeth of a single row of plates; endostome thin and membranous, sometimes lacking.

((a)). Archegonia situated on top of short, special, lateral branches; outer set of teeth usually alternating with the inner; frond usually of creeping habit; the so-called pleurocarpous mosses. *Hypnales.*

((b)). Archegonia situated at the tip of the main stem and of ordinary branches; frond usually of erect habit; usually acrocarpous mosses. *Bryales.*

b. Peristome teeth solid single or double, or rarely absent, developed from two tissue layers of the sporangium; consisting of entire cells, not transversely barred; or if developed from thickened parts of cell walls then the sporangium decidedly dorsiventral and zygomorphic; acrocarpous mosses. *Polytrichales.*

II. Venter of the archegonium sunken in the body of the gametophyte; rhizoids unicellular; sporophyte with prominent intercalary growth between the sporangium and foot; sporangium 2-valved, with a central columella. ANTHOCEROTÆ. *Anthocerotales.*

Phylum, PTENOPHYTA.

I. Sporophyte homosporous; gametophytes usually comparatively large and mostly hermaphroditic except in extreme forms. PHYLLOPTERIDÆ.

A. Sporangia eusporangiate in origin. Subclass, EUSPORANGIATÆ.

1. Sporangia on a sporangiophore distinct from the leaf blade and born on the morphologically upper side of the leaf; gametophyte subterranean, without chlorophyll. *Ophioglossales.*
2. Sporangia borne on the under side of the leaf blade, mostly forming synangia; leaves with 2 stipules; gametophyte with chlorophyll. *Marattiales.*

B. Sporangia leptosporangiate in origin. Subclass, LEPTOSPORANGIATÆ. *Filicales.*

II. Sporophyte heterosporous; gametophytes minute, unisexual; leaves not with ligules; sporangia in sori inclosed in a modified leaflet (sporocarp) or in the modified indusium; leptosporangiate. HYDROPTERIDÆ.

A. Sporangia in sporocarps; with creeping rhizomes; terminal bud with a 3-sided apical cell. *Marsieales.*

B. Sporangia in specialized indusia; small floating plants; terminal bud with a 2-sided apical cell. *Salviniales.*

III. Sporophyte heterosporous; gametophytes minute, unisexual; leaves with lingules and with sporangia borne singly, imbedded on the upper side near the base; eusporangiate. ISOETEÆ. *Isoetales.*

Phylum, CALAMOPHYTA.

1. Sporophyte homosporous; gametophytes hermaphroditic or unisexual.

A. Leaves not fused into a sheath; sporangia stalked, on the upper side of the sporophyll; stem with a central triarch vascular bundle; paleozoic fossils. SPHENOPHYLLEÆ. *Sphenophyllales.*

B. Leaves united into a sheath with teeth, sporophylls shield-shaped, with sack-like sporangia on the inner side; stem with a ring of vascular bundles and a central pith which is usually hollow. EQUISETEÆ. *Equisetales.*

II. Sporophyte heterosporous; gametophytes unisexual; paleozoic fossils. CALAMARIÆ. *Calamariales.*

Phylum, LEPIDOPHYTA.

I. Sporophyte homosporous; leaves without a ligule; gametophytes usually hermaphroditic. LYCOPODIEÆ.

A. Sporangia unilocular, Sporophylls undivided. *Lycopodiales.*

B. Sporangia bilocular or trilocular; sporophylls 2-parted. *Psilotales.*

II. Sporophyte heterosporous; leaves with a ligule; gametophytes unisexual. SELAGINELLEÆ.
   A. With increase in thickness of stem by means of a cambium; paleozoic fossil trees. Subclass, SIGILLARIEÆ. *Sigillariales.*
   B. Without increase in thickness of stem; present day herbs. Subclass, EUSELAGINELLEÆ. *Selaginellales.*

Phylum, CYCADOPHYTA.

I. Leaves usually compound; stem an unbranched shaft or with few branches.
   A. Megasporophylls only moderately or slightly differentiated from the foliage leaves; leaves fern-like, often very much compounded; no cones known; paleozoic fossils. PTERIDOSPERMÆ, *Neuropteridales,* and other imperfectly understood orders.
   B. Megasporophylls (carpels) highly specialized, usually very different from the foliage leaves; at least one kind of sporophylls in cones, the cones bisporangiate or monosporangiate. CYCADEÆ.
      1. Microsporophylls leaf-like; flowers probably all bisporangiate; fossil mesozoic plants with pinnate leaves. *Bennettitales.*
      2. Microsporophylls not leaf-like, arranged in compact monosporangiate cones; diecious, present day plants. *Cycadales.*

II. Leaves usually simple or lobed; venation dichotomous or parallel; stems with several or numerous branches, forming a crown.
   A. Without dwarf branches; leaves usually elongated, with parallel veins; fossil trees. CORDAITEÆ. *Cordaitales.*
   B. With thick wart-like dwarf branches and ordinary branches having well-developed internodes; leaves fan-shaped, dichotomously veined; sporophylls not in cones, the plant entirely flowerless; one surviving, living species. GINKGOÆ. *Ginkgoales.*

Phylum, STROBILOPHYTA.

I. No vessels (enlarged tracheids) in the secondary wood; wood frequently with resin ducts or cells; leaves mostly spiral, sometimes opposite or whorled; cotyledons 2–15. CONIFERÆ.
   A. Carpels usually numerous in ample or reduced strobili (cones); seeds covered by the carpel tips or by ovuliferous scales; cones rarely becoming fleshy when mature; seeds dry, the testa woody or leathery.
      1. Ovules single on the carpel; staminate cones large; sperms very large. *Araucariales.*
      2. Ovules 2 or more; staminate cones small; sperms not large. *Pinales.*
   B. Carpels of the cone few or one; seeds with fleshy testa or covered by a fleshy aril. *Taxales.*

II. Vessels present in the secondary wood; wood without resin ducts; embryo with 2 cotyledons; reduced strolili in specialized inflorescences; leaves opposite or in threes. GNETEÆ.
   A. Archegonia well developed; primary cambium persistent; leaves scale-like; stem green and fluted. *Ephedrales.*
   B. Archegonia reduced; concentric cortical series of vascular bundles produced; leaves ribbon-like or broad. *Gnetales.*

Phylum, ANTHOPHYTA.

I. Stems with closed, usually scattered vascular bundles; embryo usually with one terminal cotyledon and a lateral plumule; flowers mostly in threes, all except the lowest being of the pentacyclic trimerous type or a modification of this. MONOCOTYLÆ.

II. Stems with open vascular bundles, usually in a circle, with a cambium cylinder; embryo usually with 2 cotyledons and a terminal plumule; flowers mostly pentamerous or tetramerous, of many diverse types from low to high. DICOTYLÆ.

SYNOPSIS OF THE SUBCLASSES AND ORDERS OF MONOCOTYLÆ

I. Flowers with many to few free carpels, or the carpels united, in which case they are numerous, or if three, two, or apparently one, then the flowers in a spadix, usually with a spathe or the leaves segmented and fan-like or feather-like; a few with reduced flowers in glomerules and some aquatic plants extremely modified and without a perianth.

A. Aquatic or mud plants, or rarely non-green phagophytes, with primitive or highly specialized flowers, but not in a spadix or dense glomerule; hypogynous or epigynous herbs. HELOBIÆ.

1. Flowers hypogynous or somewhat perigynous or epigynous; carpels free or united, spiral or cyclic.

a. Plants normal, with chlorophyll.

(a). Hypocotyledonary expansion, if present, not lobed or only slightly notched; ovules usually anatropous or campylotropous leaves often narrow, not peltate and not with a narrow basal sinus but sometimes sagittate or deeply cordate; hypogynous. *Alismatales.*

(b). Hypocotyledonary expansion parted into two lobes or deeply notched; ovules orthotropous; aerial or floating leaves peltate or with a deep basal sinus, or if somewhat sagittate then the carpels numerous and united; hypogynous to epigynous. *Nymphaeales.*

b. Small yellowish or reddish phagophytes without chlorophyll; tropical plants growing in forests. *Triuridales.*

2. Flowers epigynous; carpels united, cyclic. *Hydrocharitales.*

B. Usually terrestrial plants, but sometimes aquatic; trees, shrubs, or herbs with segmented leaf-blades, or plants with the flowers in spadixes or dense glomerules, usually with spathes; or minute free-floating plants without leaves and with extremely reduced flowers; hypogynous, choripetalous, sympetalous or apetalous. SPADICIFLORÆ.

1. Inflorescence not a typical spadix; leaves frequently plicate and more or less split at maturity.

a. Leaves usually plicate and more or less split.

(a). Carpels free or united, usually 3, forming a unilocular or plurilocular ovulary with one ovule for each carpel. *Palmales.*

(b). Carpels united; ovulary uniocular, with numerous seeds on 2 or 4 parietal placentæ. *Cyclanthales.*

b. Leaves linear or sword-shaped, not plicate and not splitting at maturity; flowers monecious, spicate or capitate. *Pendanales.*

2. Inflorescence usually a fleshy spadix with or without a spathe; or minute plants without leaves, floating free, the flowers few or solitary, on the modified stem. *Arales.*

II. Flowers with united carpels, normally pentacyclic and trimerous or a modification or reduction of this type, often covered with glumes and then having a vestigial perianth or none whatever; if trees with pentacyclic trimerous flowers, then not in spadixes and the leaf blade not segmented.

A. Flowers reduced, in spikelets covered with glumes, the ovulary nearly always unilocular; leaves narrow and usually elongated; usually with one or all the internodes elongated; always hypogynous. GLUMIFLORÆ.

1. Ovulary 3-1-locular; ovules solitary in the cavities, orthotropous, pendulous. *Restionales.*

2. Ovulary unilocular, one-ovuled; ovules anatropous, erect or ascending. *Graminales.*

B. Flowers mostly showy and normally pentacyclic, or of a somewhat modified pentacyclic, trimerous type, rarely covered with glume-like structures; hypogynous or epigynous trees, shrubs, vines, and herbs of many types. LILLIFLORÆ.

1. Flowers hypogynous; seeds with endosperm. *Liliales.*
2. Flowers mostly partly or completely epigynous.
   a. Seeds with endosperm.
      (a). Flowers mostly regular, or only slightly zygomorphic. *Iridales.*
      (b). Flowers very irregular, usually zygomorphic. *Scitaminales.*
   b. Seeds without apparent endosperm, very numerous and usually minute; flowers mostly irregular and zygomorphic. *Orchidales.*

SYNOPSIS OF THE SUBCLASSES OF DICOTYLÆ

I. Flowers normally choripetalous or apetalous, some sympetalous but then mostly with central placenta; usually not epigynous and at the same time in umbels.
   A. Flowers hypogynous or perigynous, rarely epigynous.
      1. Floral organs usually inserted directly on the floral axis.
         a. Flowers with distinct carpels, or if the carpels are united usually with a plurilocular ovulary, if with a unilocular ovulary then usually with parietal placentæ; mostly with petals. THALAMIFLORÆ.
         b. Flowers usually with united carpels, the ovulary with a central ovule or placenta, often apetalous but sometimes choripetalous or sympetalous. CENTROSPERMÆ.
      2. Floral organs usually on a hypanthium which may be extremely reduced, in which case the flowers are commonly in aments or ament-like clusters; occasionally apparently epigynous.
         a. Petals commonly present; flowers not in ament-like clusters. CALYCIFLORÆ.
         b. Petals usually absent or much reduced; flowers commonly in aments or ament-like clusters. AMENTIFERÆ.
   B. Flowers usually epigynous, with or without a hypanthium, sometimes sympetalous. MYRTIFLORÆ.

II. Flowers typically sympetalous, rarely apetalous, but sometimes choripetalous and then commonly in umbels and epigynous.
   A. Flowers mostly hypogynous, if epigynous then the stamens opposite the lobes of the corolla or twice as many; occasionally the flowers are epigynous with alternate stamens.
      1. Flowers pentacyclic, or with as many carpels as petals, or if tetracyclic then the stamens mostly free from the corolla, if the stamens are united with the corolla then usually opposite its lobes. HETEROMERÆ.
      2. Flowers tetracyclic; carpels usually 3 or 2; stamens united with the corolla, as many as or fewer than its lobes and alternate with them; corolla mostly tubular. TUBIFLORÆ.
   B. Flowers epigynous, tetracyclic or less, with the stamens alternate with the corolla lobes, often in dense heads, if choripetalous then usually in umbels; calyx frequently minute or absent or replaced by a specialized pappus. INFERÆ.

The preceding synopsis of the subclasses of Dicotylæ probably does not give an entirely correct picture of the fundamental segregative movements. These are, in our present state of knowledge, difficult to discover in the enormous mass of more than 125,000 known species. The accompanying chart of the phyletic relationships is constructed on a somewhat different basis and indicates the evolutionary segregation to be about as follows:

I. Mostly hypogynous.
   A. Mostly choripetalous or apetalous.
      1. Mostly choripetalous and mostly not with central placentation. THALAMIFLORÆ.
      2. Typically apetalous but some choripetalous or sympetalous; mostly with central placentation. CENTROSPERMÆ.

B. Mostly sympetalous.
1. Flowers pentacyclic or some reduction from this type; carpels commonly 5. HETEROMERÆ.
2. Flowers tetracyclic or less; carpels mostly 2, occasionally 3. TUBIFLORÆ.

II. Mostly perigynous or epigynous, or with a reduced perigynous condition.
A. Mostly perigynous and mostly choripetalous or apetalous.
1. Petals commonly present; flowers usually not in ament-like clusters; hypanthium mostly prominent. CALYCIFLORÆ.
2. Mostly apetalous; flowers at least the staminate commonly in aments or ament-like clusters; hypanthium mostly inconspicuous or reduced. AMENTIFERÆ.
B. Epigynous, with or without a hypanthium; mostly choripetalous or sympetalous, occasionally apetalous.
1. Mostly choripetalous and not in umbels; epigynous hypanthium frequent. MYRTIFLORÆ.
2. Typically sympetalous, the choripetalous groups mostly in umbels; epigynous hypanthium rare; calyx often reduced or replaced by a specialized pappus; flower frequently in disks and heads. INFERÆ.

Subclass, THALAMIFLORÆ.

I. Carpels many to one, spiral or cyclic, usually free or only slightly united; stamens usually numerous. *Ranales.*

II. Carpels usually more or less united, cyclic.
A. Herbs with insectivorous leaves; carpels 6–3. *Sarraceniales.*
B. Herbs or woody plants with normal leaves, not insectivorous.
1. Carpels 2 or more with parietal placentæ; perianth usually with an even number of segments, the flowers commonly partially or completely isobilateral. *Brassicales.*
2. Carpels mostly 5 or 3; stamens mostly 10 or 5, or a reduction from 10; ovules mostly pendulous; flowers commonly of the hexacyclic type, one cycle being represented by glands. *Geraniales.*
3. Carpels many to 3, ovules few; stamens indefinite, monadelphous, branched or clustered, or by reduction separate and few; sepals valvate. *Malvales.*
4. Carpels 2 or more, commonly with parietal placentæ; stamens numerous to few; sepals and petals usually 5, sepals imbricated or convolute. *Violales.*

Subclass, CENTROSPERMÆ.

I. Perianth present, consisting of a calyx and corolla, or of a calyx only.
A. Fruit not an achene or rarely so.
1. Corolla usually choripetalous or none.
a. Embryo straight; fruit a capsule. *Tamaricales.*
b. Embryo curved, coiled, or annular.
(a). Fruit a capsule, berry or anthocarp; calyx present; corolla present or absent. *Caryophyllales.*
(b). Fruit a utricle; calyx present; corolla usually none. *Chenopodiales.*
2. Corolla mostly sympetalous; fruit fleshy, or a dry capsule, utricle, or achene. *Primulales.*
B. Fruit an achene; embryo straight or nearly so; stipules commonly ocreæ. *Polygonales.*

II. Perianth none or vestigial; ovules usually orthoptropous. *Piperales.*

Subclass, CALYCIFLORÆ.

I. Carpels free or united, spiral or cyclic.

A. Endosperm usually little or none; leaves mostly with stipules; carpels spiral or cyclic, often reduced to one, usually free or only slightly united, with a few evident exceptions. *Rosales.*
B. Endosperm present and usually copious; leaves usually without stipules; carpels cyclic, free or united, sometimes slightly epigynous. *Saxifragales.*

II. Carpels united, cyclic.
A. Hypanthium tubular or urn-shaped, often constricted above and enclosing the ripe fruit; endosperm commonly little or none. *Thymelales.*
B. Receptacle developing a glandular, annular or turgid disk which is somewhat united with the perianth or ovulary, endosperm present or none. *Celastrales.*
C. Disk tumid, united with the perianth, sometimes reduced; endosperm usually none. *Sapindales.*

Subclass, AMENTIFERÆ.

I. Flowers not in typical aments, often in pendent heads or ament-like spikes or clusters; usually monosporangiate.
A. Leaves alternate or rarely opposite.
1. Stamens alternate with the petals (when present), or numerous; perianth sometimes none. *Platanales.*
2. Stamens mostly 4, opposite the usually 4 sepals.
a. Calyx not petaloid. *Urticales.*
b. Calyx petaloid, stamens usually united with the sepals. *Proteales.*
B. Leaves whorled, reduced to scales; ovulary unilocular, with 2 ovules. *Casuarinales.*

II. Flowers, at least the staminate ones, in aments; monosporangiate.
A. Seeds not with a tuft of hairs, fruit a typical or modified nut, achene, or samara; plants monecious or diecious.
1. Fruit two- or several-seeded; ovules with one integument; diecious trees or shrubs. *Balanopsidales.*
2. Fruit usually one-seeded. *Fagales.*
B. Seeds with a tuft of hairs at one end; several in the capsule; flowers normally diecious, without perianth; leaves usually alternate. *Salicales.*

Subclass, MYRTIFLORÆ.

I. Petals usually numerous, rarely wanting; mostly fleshy, usually prickly and spiny plants with jointed stems and reduced leaves or the stem not jointed but the leaves fleshy. *Cactales.*

II. Petals usually not more than 5 or often none; trees, shrubs, or herbs not spiny like the preceding; calyx segments rarely more than 5.
A. Petals usually present, choripetalous; sometimes apetalous or sympetalous.
1. Flowers usually bisporangiate; placentæ usually axile or apical, rarely basal or parietal. *Myrtales.*
2. Flowers bisporangiate or monosporangiate; placentæ usually parietal; mostly herbs or herbaceous vines. *Loasales.*
B. Petals usually absent, if present either choripetalous or sympetalous.
1. Ovulary usually with several cavities, usually 6-locular; herbs or vines, sometimes parasitic. *Aristolochiales.*
2. Ovulary unilocular; mostly parasitic shrubs or herbs. *Santalales.*

Subclass, HETEROMERÆ.

I. Stamens mostly free from the corolla, alternate with its lobes or twice as many; seeds minute; flowers mostly bisporangiate, hypogynous or epigynous, sometimes choripetalous. *Ericales.*

II. Stamens united with the corolla and opposite its lobes or twice as many or more; seeds usually one or few in the cavities, usually large; flowers hypogynous or sometimes epigynous, sometimes choripetalous. *Ebenales.*

Subclass, TUBIFLORÆ.

I. Corolla not scarious, nerved.
   A. Fruit usually a capsule berry, drupe, or samara; carpels commonly severed- to many seeded.
      1. Corolla regular; stamens usually of the same number as the corolla lobes.
         a. Leaves alternate or opposite; ovularies not separating. *Polemoniales.*
         b. Leaves usually opposite, ovularies frequently separating below, with a common style; if not separating, then usually with 2 cavities or 2 placentæ. *Gentianales.*
      2. Corolla mostly irregular or oblique; fertile stamens commonly fewer than the corolla lobes except in the lower species. *Scrophulariales.*
   B. Fruit indehiscent but usually splitting and forming 4 nutlets around the style, rarely fleshy; carpels 1–2–seeded. *Lamiales.*

II. Corolla usually scarious, nerveless; calyx and corolla 4-lobed. *Plantaginales.*

Subclass, INFERÆ.

I. Anthers separate.
   A. Corolla choripetalous; flowers usually in umbels or cymes. *Umbellales.*
   B. Corolla sympetalous. *Rubiales.*

II. Anthers with few exceptions united; corolla sympetalous, sometimes absent.
   A. Flowers not in involucrate heads. *Campanulales.*
   B. Flowers in dense involucrate heads; gynecium of 2, or rarely 3, united carpels, unilocular; seed one. *Compositales.*

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